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OF THE

SECRETARY OF AGRICULTURE.

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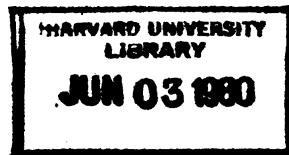
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REPORT
OF THE
SECRETARY OF AGRICULTURE.

TO THE PRESIDENT:

I have the honor to submit herewith my Ninth Annual Report as Secretary of Agriculture.

INTRODUCTORY.

The well-being of the American farmer is a matter of profound interest to the entire country. It is, therefore, in the highest degree gratifying to present for your consideration the following evidences of the unprecedented prosperity which has in this and recent years rewarded the diligence of the farmer and the efforts of this Department on his behalf.

FARMER'S WEALTH AND WELL-BEING.

UNSURPASSED PROSPERITY.

Another year of unsurpassed prosperity to the farmers of this country has been added to the most remarkable series of similar years that has come to the farmers of any country in the annals of the world's agriculture. Production has been unequaled; its value has reached the highest figure yet attained; the value of the farmers' National surplus still maintains the magnitude that has built up the balance of trade by successive additions for many years sufficient to change the Nation from a borrower into a lender; there is a continuation of the unprecedented savings that have embarrassed local banks with their riches and have troubled farmers to find investments; and, as if all of these manifestations of a high degree of well-being were not enough, the farms themselves have increased in value to a fabulous extent.

Farm crops have never before been harvested at such a high general level of production and value. The partial failure of two or three second-class crops makes no apparent impression upon the great aggregate of all crops.

After much laborious collection of information an estimate of the value of the crops of 1905 and of all other farm products has been made, as was done last year. The census's detailed statement of the value of all farm products was taken as the basis, and the various items have been brought down from year to year in their quantities and values. For such crops as will later receive a final estimate by the Bureau of Statistics of this Department, the figures herein used are subject to small correction. All values adopted for the various products are farm values, and are in no wise to be mistaken for exchange, middleman's, or consumer's values.

HIGH CROP VALUES.

Corn has reached its highest production with 2,708,000,000 bushels, a gain of 42,000,000 over the next lower year, 1899. In value, also, the corn crop of this year is higher than that of the next lower year, 1904, by \$128,000,000, and the total value may be \$1,216,000,000. No other crop is worth more than half as much.

Hay.—Second in order of value among all kinds of crops is the hay crop, which takes the second place back from the cotton crop, which held it for the two preceding years. Many hay crops have exceeded in tons the product of this year, but because of high prices the crop reaches a value of \$605,000,000, which is higher by \$34,000,000 than the value of the crop of 1893.

Cotton, including seed, stands third in value among the leading crops of the year, although some uncertainty still remains concerning its quantity and value. It can only be said that its value, including seed, is expected to rise well toward \$575,000,000, and will be nearer to that figure, or above it, in proportion as the expectations of cotton planters are realized with regard to higher prices.

Wheat.—Fears last year that the United States had fallen to the level of its consumption in the production of wheat were ill-founded. The short crop of that year is followed this year by the second wheat crop in size that this country has ever produced, 684,000,000 bushels, and the value of this crop, \$525,000,000, overtops the highest value before reached, in 1891, by \$11,000,000.

Oats.—Fifth in order of value among the crops of the year is the oat crop, with 939,000,000 bushels, or 50,000,000 bushels under the highest production, in 1902. In value as well as yield the oat crop of this year has been exceeded in only two previous years, amounting to \$282,000,000, only \$22,000,000 under that of 1902.

Potatoes.—Next after oats comes the potato crop, which has been a partial failure and falls below the highest production of preceding years, that of 1904, by 72,000,000 bushels; but in value the crop has

done better, since it occupies the fourth place from the highest, and is valued at \$138,000,000, or only \$13,000,000 below the highest preceding value, that for 1903.

Barley.—The high price of barley during the last three years has much increased the size and value of this crop, so that it now occupies seventh place among the leading agricultural crops. In quantity the crop of this year, 133,000,000 bushels, is third among annual barley crops, though only 7,000,000 bushels under the highest crop, that of 1904, and has a value of \$58,000,000, or only \$4,000,000 under the most valuable crop of this cereal, that of 1902.

Tobacco, like potatoes, is an undersized crop this year, as it was last year, and, considering the difficulties in the way of placing a value upon it at this time, an estimate of \$52,000,000 may be too low. At any rate, because of high prices, the entire crop almost exceeds the highest value yet reached, that of 1899.

Sugar cane and sugar beets.—Although unrelated in culture, the common purpose of growing sugar beets and sugar cane permits their combination in a statement that their united value this year is estimated to be in the neighborhood of \$50,000,000. This is a farm value for the raw material from which sugar, sirup, molasses, and feeding stuffs are derived in processes of manufacture.

Rice.—The rice crop is not as valuable as some other crops which are not mentioned here, yet its remarkable position entitles it to notice. Its production increased from 250,000,000 pounds of rough rice in 1899 to 517,000,000 pounds in 1903 and to 928,000,000 pounds in 1904; but the extraordinary production of 1904 fell to 637,000,000 pounds this year, and, although second in quantity, this year's crop is probably worth more than the crop of 1904, which was valued at \$13,892,000.

Exceptional general level.—While it may be observed that only one crop—corn—reached its highest production this year, four crops reached their highest value—namely, corn, hay, wheat, and rice. The general level of production was high and that of prices still higher, so that no crops for which separate estimates can be made fall below third place in total value compared with the crops of preceding years, except potatoes, barley, tobacco, rye, and buckwheat. The cereals, including rice, more than maintained their previous strong position in production, and their aggregate yield is 4,521,000,000 bushels, with a farm value of \$2,123,000,000, or \$145,000,000 over last year.

DAIRY AND POULTRY PRODUCTS.

Butter and milk.—Both butter and milk have higher prices in 1905 than in 1904, and these, combined with increased production, permit

an estimate of the value of dairy products at \$665,000,000, or \$54,000,000 above the estimate for last year. No crop but corn produces the income that the dairy cow does.

The farmer's hen is becoming a worthy companion to his cow. The annual production of eggs is now a score of billions, and, after supplying the needs of factories, tanneries, bakeries, and other trades, they are becoming a substitute for high-priced meats, besides entering more generally into the everyday food of the people. Poultry products have now climbed to a place of more than half a billion dollars in value; and so the farmer's hen competes with wheat for precedence.

TOTAL WEALTH PRODUCTION ON FARMS.

Dreams of wealth production could hardly equal the preceding figures into which various items of the farmer's industry have been translated; and yet the story is not done. When other items, which can not find place here, are included, it appears that the wealth production on farms in 1905 reached the highest amount ever attained by the farmer of this or any other country, a stupendous aggregate of results of brain and muscle and machine, amounting in value to \$6,415,000,000.

The deduction from wealth produced, made in the report of last year on account of products fed to live stock, is not continued this year because the duplication of produced wealth in the consumption of products by farm animals is much less than has been assumed and is undoubtedly more than offset by the amount of wealth produced on farms which can not be estimated or even ascertained practically by census enumerators.

It might reasonably have been supposed in 1904 that the wealth produced by farmers had reached a value which would not be equaled perhaps for some years to follow, and yet that value is exceeded by the value for this year by \$256,000,000, just as the value for that year exceeded that for 1903 by \$242,000,000.

The grand aggregate of wealth produced on farms in 1905 exceeds that of 1904 by 4 per cent; it is greater than that of 1903 by 8 per cent; and transcends the census figures for 1899 by 36 per cent, and this after a lapse of only six years.

If there is no relapse from this high position that the farmer now holds as a wealth producer, three years hence he may look back over the preceding decade, and, if he will add the annual figures of his wealth production, he will find that the farming element, or about 35 per cent of the population, has produced an amount of wealth within these ten years equal to one-half of the entire National wealth produced by the toil and composed of the surpluses and savings of three centuries.

DOMESTIC ANIMALS.

Horses.—In the last annual estimate made by this Department of the number and value of domestic animals on farms, nearly a year ago, it appears that the farmers' horses had never before been so numerous nor in the aggregate so valuable. First threatened by the bicycle, and later by the suburban trolley car and the automobile, neither one of these, nor all combined, have scared the farmers' horses into diminished numbers or lower prices. On the contrary, horses on farms last winter were worth \$1,200,000,000, or nearly as much as the corn crop of this year, and their number was over 17,000,000. Mules also are steadily increasing, and are worth \$252,000,000.

Cattle.—Milch cows also are advancing in numbers and have reached a total of 17,570,000, worth \$482,000,000. Other cattle, however, have not participated in this advance, and in recent years have declined in number and total value so that last winter they numbered 43,669,000, worth \$662,000,000.

Sheep and swine.—Sheep, too, are declining in number and in total value, but swine are holding their previous position of many years, the number being 47,321,000, valued at \$283,255,000.

Aggregate increase.—In the aggregate, the value of farm animals of all sorts has increased a few million dollars within a year and has increased \$249,000,000 since the census of 1900, or 9 per cent.

FEATURES OF FOREIGN TRADE.

Unparalleled agricultural surplus.—Out of the enormous productions of the farms of this country the wants of 83,000,000 people have been supplied, and there remains a surplus large enough to become a generous contribution to the other nations of the earth and unparalleled among them as a National agricultural surplus.

During the last fiscal year (ending June 30, 1905) the exported domestic farm products were valued at \$827,000,000. This was \$51,000,000 below the annual average of the five preceding years, although it was \$132,000,000 above the average of the five years 1895–1899, and \$157,000,000 above the average of 1890–1894.

There was a loss of \$32,000,000 as compared with the exports of farm products for the fiscal year 1904. In accounting for this it is proper to notice that the decrease in the exports of grain and grain products, due to the short wheat crop, equaled \$41,000,000. To this decrease is to be added a reduction of \$5,000,000 in exports of packing-house products, and another of \$5,000,000 in fruits, and various minor items.

On the other hand, however, there were increases of \$9,350,000 in

exports of cotton; \$4,700,000 in oil cake and oil-cake meal; \$4,000,000 in vegetable oils; \$2,000,000 in rice, and various minor increases.

The relative position of farm products in domestic exports is a declining one on account of the gain in exports of manufactures, so that, while the exports of the former averaged 62.6 per cent of all domestic exports for the five years 1900-1904, the percentage for 1905 was only 55.4 per cent.

During the last sixteen years the domestic exports of farm products have amounted to \$12,000,000,000, or \$1,000,000,000 more than enough to buy all the railroads of the country at their commercial valuation, and this with a mere surplus for which there was no demand at home.

Imports mostly noncompetitive.—In the matter of imports of farm products the total of the last fiscal year was \$554,000,000, or \$125,000,000 more than the annual average of the preceding five years. Over 1904 the gain was \$92,000,000, which is accounted for by large increases in the imports of silk, wool, hides and skins, coffee, sugar, and molasses, against which there were relatively small decreases in imports of feathers, rice, tea, and vegetables. The imports of farm products in 1905 were 49.6 per cent of all imports, as compared with 46.7 per cent during the preceding five years.

Apparent balance of trade.—While the farmer has been a producer and a trader, he has also been an international paymaster. In his foreign trade of 1905 he had a net balance in his favor amounting to \$285,000,000; in the preceding five years this favorable balance averaged \$461,000,000; during the five years 1895-1899 it averaged \$338,000,000, and in the five years preceding that the average was \$271,000,000.

During the sixteen years past the farmer has secured a balance of \$5,635,000,000 to himself in his international bookkeeping, and out of this he has offset an adverse balance of \$543,000,000 in the foreign trade in products other than agricultural, and turned over to the Nation from his account with other nations \$5,092,000,000.

Foreign trade in forest products.—Notwithstanding the constant weakening of the National forest resources, the exports of forest products had been increasing for many years, but during the fiscal year 1905 their value was \$63,000,000, which was a decline of \$6,300,000 from the preceding year.

Imported forest products are either noncompetitive with those of the Nation or introduced from Canada because of insufficient domestic production. The imports of 1905 were valued at \$92,000,000, an increase of \$12,000,000 over the preceding year, mostly on account of increased imports of india rubber, but partly on account of increased imports of lumber and wood pulp from Canada.

FARMERS' SUPPORT OF MANUFACTURING.

Not content with his other achievements, the farmer lends his strong shoulder to the support of the manufactures of the country by furnishing raw materials. Computations based upon census information disclose the fact that farm products, to some extent obtained from other countries, constitute 56.4 per cent of the total products, and 86.8 per cent of the total materials, of the industries utilizing agricultural products as materials, and these industries produce 36.3 per cent of all manufactured products and use 42 per cent of all materials employed in manufacturing.

At the same time these industries using agricultural materials employed 37.8 per cent of all persons engaged in manufacturing, and the capital of these industries is 42.1 per cent of the capital of all manufacturing establishments.

Restated in absolute terms, during the last census year the farm products employed in manufactures were valued at \$2,679,000,000; the value of all materials, including the preceding amount, was \$3,087,000,000; and the products of the industries using these materials were valued at \$4,720,000,000. These industries employed 2,154,000 persons and had a capital of \$4,132,000,000.

Such are the enormous interests, not engaged in agriculture, but in industries that could not maintain themselves without the farmer and his extraordinary productive ability.

FARMERS BECOMING BANKERS.

Naturally such a large class of the population as the farmers, producing wealth and surpluses to the extent that they are, have savings which they invest in various ways, since in this country the stocking and its hiding place are not the savings bank. One of the most notable outgrowths of savings by farmers is the very great multiplication of small national banks in recent years. Under the amendment to the national banking act, permitting the organization of banks with a capital of less than \$50,000, as many as 1,754 of these banks were organized from March 14, 1900, to October 31, 1905, excluding those organized in the noncontiguous possessions. These banks are distributed mostly throughout the South and the North Central States in rural regions, where they depend for their business primarily and directly upon the farmers' prosperity and, secondarily, upon the village merchants and persons of other employment, who themselves are dependent upon the prosperity of the farmers.

In the Southern States 633 of these banks were organized, representing 36.1 per cent of the total number; in the North Central States the number was 792, or 45.2 per cent of the total. To one who

is familiar with State and regional conditions it is significant to notice that in the North Central States west of the Mississippi River 513 of these banks were organized, representing 29.3 per cent of the total number, and that in the Southwestern region, embracing Texas, Indian Territory, and Oklahoma, 397 new small banks stand for 26.2 per cent of the total.

If the capital of these banks had been sent from Boston and New York it would have been such a proceeding as was common fifteen years ago; but, instead of coming from such an origin, the capital of these banks has come from the farmers. The State bank commissioner of Kansas, in his report for 1904, states that "it has been an era of small banks in isolated communities, and so many have been started that to-day every hamlet in the State where any considerable business is done has a bank. This increase in the number of small banks arises, first, from the fact that farmers and business men in these communities had idle money that they desired to invest and banking appealed to them," etc. The same cause for the establishment of these banks is reported from the South and North Central and Western groups of States.

DEPOSITORS IN BANKS.

In the North Central States farmers have been depositing money in the banks until the rate of interest on deposits has fallen so low that they have diverted a large portion of their savings to permanent investments. In spite of the fact that the banks do not receive and keep all or most of the farmers' savings, the increase of bank deposits in agricultural States and larger regions is most extraordinary. The following are some examples of the increase of the deposits in all banks in the agricultural States during the year ending June 30, 1905: In Iowa and South Dakota the increase was 14.9 per cent; in Nebraska, 13.5; in Kansas, 9.7; in North Dakota, 25. During the same time bank deposits in the great capital State of Massachusetts increased 9.1 per cent.

Still more remarkable is the bank statement for the South Central States. During the past year the deposits increased 18.1 per cent in Texas, 21.4 in Oklahoma, 24.1 per cent in Arkansas, and 45.7 per cent in the Indian Territory, while throughout the whole area of that geographic division the increase was 22.8 per cent. The general average increase for the United States was 13.5 per cent.

If a comparison is made with 1896, within the latest prolonged financial depression, the comparisons are still more striking. During the ten years from that year to June 30, 1905, the bank deposits of the United States, all banks included, increased 129.2 per cent. In comparison with this is the increase of the South Atlantic States, 167.4 per cent; of the Western or Rocky Mountain and Pacific States,

169.8 per cent; of the North Central States, 185.5 per cent; and still more striking is the percentage of the South Central States, 255.7 per cent; while during the same time the deposits in the North Atlantic States increased only 102.3 per cent.

For individual States there are such increases during the ten years as 190.9 per cent for Iowa, 239.3 per cent for Kansas, 294 per cent for North Dakota, and 355.7 per cent for South Dakota. The progress of the South Central States was still more rapid, as evidenced in particular by Mississippi, with an increase of 347.1 per cent in bank deposits; by Texas, 248 per cent; by Oklahoma, 172.6 per cent; and by Arkansas, with 503.8 per cent.

For the first time in the financial history of the South, deposits in the banks of that region now exceed \$1,000,000,000.

The foregoing remarkable increases in bank deposits in agricultural States, as well as the increase in the number of small country banks, are directly and indirectly because of the profits that have come to the farmers from the operation of their farms. The man with the hoe has become the man with the harvester and the depositor and shareholder of the bank.

DECADENCE OF THE CROP LIEN.

Nothing has been of greater financial moment to the cotton planters than the profitable price of cotton during the past three years. It has been the means of lifting them out of a rut that at times filled them with despair. The crop lien, that was a necessity immediately after the civil war, is disappearing where it has not already gone and released the planters from its bondage.

For the first time in nearly half a century the cotton planter's unsecured note is now good at the bank, and his land is a safe security and is salable.

INCREASE IN FARM VALUES.

Such an account of the farms of the United States as is given in the foregoing matter may seem too optimistic in tone and too extravagant in expression. With the expectation that the story of the year would present this appearance, and to verify or discredit it, the Department undertook and has just completed an investigation of the changes in the values per acre of medium farms since the census of 1900. The net result of these changes is an enormous increase in the values, which increase is entirely consonant with the period of high prosperity that the farmers have enjoyed since 1900, the only considerable blot upon an otherwise clean record of these years being the very deficient corn crop of 1901.

Inquiries were addressed to 45,000 correspondents, representing almost every agricultural neighborhood in the United States, and the

returns of these correspondents warrant the statements that follow. The values asked for and reported include the buildings and all improvements, but no personal property.

Percentage of gain.—During the five years last past the value of the real estate of medium farms of this country has increased 33.5 per cent, as compared with the census increase of 25 per cent for the real estate of all farms from 1890 to 1900. The highest percentage of increase—40.8 per cent—is found in the South Central group of States. Next to this is 40.2 for the Western group, which includes the Rocky Mountain and Pacific States. Third in order is the South Atlantic group, with 36 per cent of increase. The North Central States, containing most of the great cereal and live-stock surplus region, increased 35.3 per cent, and lowest of all was the increase of the North Atlantic States—13.5 per cent. Thus it appears that the medium farms of the South have increased in value in a greater degree than the medium farms of the entire North as far west as the Rocky Mountains.

Farms are classified according to their principal sources of income, conforming substantially to the census classification for 1900. With this understanding, correspondents report an increase of 46.9 per cent in value per acre for the medium cotton farms during the five years, 35 per cent for the hay and grain farms, 34.3 per cent for the live-stock farms, and 33.2 per cent for the farms devoted principally to sugar cane and sugar beets. Rice farming follows with an increase of 32.2 per cent in value per acre, while close to this is 32.1 per cent for tobacco farms. Next in order are the farms devoted to general farming, with an increase of value per acre amounting to 30.1 per cent, after which are the fruit farms, with an increase of 27.9 per cent; vegetable farms, 26.7 per cent; and, lowest of all, the dairy farms, with an increase of 25.8 per cent.

Dollars of gain per acre.—When a comparison is made among the various regions of the country and among the various classes of farms with regard to the number of dollars of increase, rather than the percentage of increase, the results are very different from the preceding. The medium farms of the North Central division increased on the average \$11.25 per acre during the five years. In the Western division of States the increase was \$5.36; in the North Atlantic States, \$5.26; while the increases were lowest in the South, where in the South Atlantic division the gain was \$4.93, and in the South Central, \$4.66. The average increase per acre of medium farms in the United States, all classes combined, was \$7.31.

Although the rate of increase for cotton farms was highest of all specialized farms, the amount of increase per acre was lowest, or \$5.18. Next above this is rice, with \$5.97; live stock, with \$6.40; and general farming, \$6.78. Rising considerably above this was the increase for

dairy farms, \$8.53; tobacco farms, \$9.13; and hay and grain farms, \$9.43. The highest increases are for vegetable farms, \$11.10; sugar farms, \$12.34; and fruit farms, \$15.71.

Causes of increase.—While some decreased values were found in a few places, due to local causes, the general fact of large increases in farm values was explained by correspondents with much particularity. The increase is chiefly due to better prices and more profitable results of farm operations, leading to a higher capitalization of land on account of increased net profit. But this by no means fully accounts for the marked increase discovered in farm values, when secondary causes are considered. Everywhere is revealed a more intelligent agriculture; the farmers are improving their cultural methods and are changing from less profitable to more profitable crops. They are discovering that high cost of production attends extensive agriculture, and that, on the contrary, intensive culture and intensive crops increase the net profits per acre. As disclosed in the preceding increases of average acre values, the farms of the less intensive culture and crop have increased in value less than the farms having the more valuable crops receiving high culture.

Other causes for higher values are the erection of new buildings, the keeping of buildings in better repair, better fences, tile draining of land that has been too wet, and a general improvement in farm thrift. New facilities for transportation, where existing, are everywhere reported as at once raising the value of farm lands, whether new railroads or wagon roads that will permit the hauling of larger loads and for longer distances.

Another cause of increase which has had a distinct effect by itself is the growing desire and ability of farmers, and townspeople also, to invest in farm lands as affording a safe investment, even though the rate of interest, as values now are, is not high.

Many minor causes have cooperated with the foregoing to bring about the wonderful increase in farm values during the past five years that the Department has discovered.

Grand aggregate increase of value.—The correspondents reporting with regard to this matter were requested to state increases and decreases for medium farms. There are reasons for believing that the increases for this class of farms may be extended to farms below and above the medium without a material distortion of the fact as representing all farms. While the increases reported for medium farms are higher than for the more poorly kept and less productive farms, on the other hand they are lower than for the better kept and more productive farms of the highest class, which are not covered in the reports of correspondents.

Accepting, then, the increased average acre values of the various

classes of medium specialized and general farms as applicable to all farms, including those above and below medium, with such pertinent qualifications as may be made, these increases are applied to the total number of farms of the various classes with results which, it is believed, are approximately correct.

With this understanding it is found that the cotton farms have increased in value \$460,000,000, the most prominent increase among the States being Texas, with \$115,000,000, while Georgia stands second with \$77,000,000, and Mississippi third with \$62,000,000. Therefore, it may be said that during the last five years the cotton plantations have had six crops of cotton, one of these crops being a permanent investment and promising to pay a good return year by year.

Sugar farms have increased in value \$20,000,000, more than half of which is found in Louisiana and one-sixth in California.

Hay and grain farms have such an immense acreage that the increase for them amounts to \$2,000,000,000, three-fourths of which is in the North Central States; and an even greater gain, or \$2,263,000,000, was made by the live-stock farms, nearly three-fourths of this also being in the North Central States. In the case of farms having dairying as a specialty the increased value was \$369,000,000; tobacco farms increased \$57,000,000; rice farms, \$3,300,000; fruit, \$97,000,000; vegetable farms, \$113,000,000; and farms devoted to general and miscellaneous purposes, \$768,000,000.

In the grand aggregate of all farms of all classes the increased value equaled the enormous total of \$6,133,000,000.

Every sunset during the past five years has registered an increase of \$3,400,000 in the value of the farms of this country; every month has piled this value upon value until it has reached \$102,000,000; that portion of the National debt bearing interest is equaled by the increased value of farms in nine months, and this increase for a little over a year balances the entire interest and noninterest bearing debt of the United States.

This increased value that has come to farms is invested better than in bank deposits or even in the gilt-edged bonds of private corporations.

ECONOMIC POSITION OF FARMERS.

If the farmers' economic position in the United States is to be condensed to a short paragraph, it may be said that their farms produced this year wealth valued at \$6,415,000,000; that farm products are yearly exported with a port value of \$875,000,000; that farmers have reversed an adverse international balance of trade, and have been building up one favorable to this country by sending to foreign nations a surplus which in sixteen years has aggregated \$12,000,000,000, leaving an apparent net balance of trade during that

time amounting to \$5,092,000,000 after an adverse balance against manufactures and other products not agricultural, amounting to \$543,000,000, has been offset. The manufacturing industries that depend upon farm products for raw materials employed 2,154,000 persons in 1900 and used a capital of \$4,132,000,000. Within a decade farmers have become prominent as bankers and as money lenders throughout large areas; and during the past five years prosperous conditions and the better-directed efforts of the farmers themselves have increased the value of their farms 33.5 per cent, or an amount approximately equal to \$6,133,000,000.

In presenting this the first Annual Report of the third term of the present incumbent of the office of Secretary of Agriculture it has seemed desirable to deviate somewhat from the usual character of this document. As a rule, these reports cover the operations of the Department for a single year, and give considerable space to recording instances of new work undertaken and of partial progress made in the work being carried on. The principal purpose of the present report is to review the work of the Department during the past eight years, and to present for consideration work not only begun but actually accomplished during that period on behalf of the farmer.

WEATHER BUREAU.

SUMMARY OF ACHIEVEMENTS.

The results accomplished by the Weather Bureau for the benefit of the farmer, the mariner, the shipper, the manufacturer, and the seeker after health or pleasure prove that there is no weather service anywhere in the world comparable with it. In recent years it has been equipped with standard instruments, apparatus, and furnishings of the latest design; daily maps are printed at nearly 100 of its local stations; large glass maps, containing the current weather reports, are exhibited each morning before important commercial associations; maps, printed or milleographed, are distributed within three hours from the time that the observations are made. Climatic statistics for the various States are collected from nearly 4,000 voluntary observers using standard instruments, and printed in the form of monthly State bulletins, so that the climate of one region can be readily compared with that of another. It has extended its network of stations around the Caribbean Sea and the Gulf of Mexico, so that no destructive tropical storm may come without warning. It has established stations in Bermuda and in the Bahamas, and arranged for cable cooperation in the Azores and along the western coast of Europe, which enables it to make forecasts for two or three days in advance for steamers leaving this country, and to warn steamers leaving Europe for America of severe storms which they

may encounter on their western voyage. With kites and mountain stations it has explored the upper air and gained useful knowledge. It has conducted experiments in wireless, or space, telegraphy, and developed one of the best wireless systems now in use. It has extended its system of telegraphic and climatic observations, so that now, except in some portions of the Rocky Mountain States, the temperature and rainfall conditions of nearly every county can be ascertained. These observations are of great value in the development of the arid and subarid regions, especially in the organization of the extensive irrigation works recently authorized by Congress.

The average per annum increase in the cost of the weather service during the past ten years is 4.41 per cent. During the same period the daily distribution of forecasts and warnings, or of printed charts containing the daily meteorological data of the United States, has increased from 22,582 to 622,880 copies, of which 158,000 represent printed reports.

DISCIPLINE.

There is no part of the Government service in which rigid discipline is more necessary to its well being than in the United States Weather Bureau, which has to do with the saving of life and property. While its observations are made with scientific precision, yet its warnings of danger from floods, gales, or frigid air are the results of experience rather than mathematical reasoning; and, therefore, even with the maintenance of the highest forms of the merit system of appointment, promotion, and preferment, there will still be a small percentage of error in its warnings.

The Weather Bureau has developed and put into effect a fair, yet rigid, discipline for the control of its personnel—a system of merit in which each person works out his own status to such an extent that it is practically impossible for an incompetent or undeserving person to reach any important post of duty. With this discipline there is associated a system of study and examination which develops the intellectuality of those who receive advancement. Aided by such a discipline it has, with rare exceptions, given timely warning of the coming of injurious changes in temperature, and allowed no important storms or floods to come unannounced.

INCREASE OF SCIENTIFIC RESEARCH.

The present appropriation for the support of the Bureau is \$1,392,990. This is the amount to be expended during the current fiscal year in applying the inexact science of meteorology to the commerce and the industries of the United States, and to the saving of human life. A knowledge of the coming weather enters so intimately into every contemplated human action that the question is often asked:

What are the prospects for further improvement in the accuracy of weather forecasts, and can the seasons ever be foretold? The answer is that the Government has a corps of forecasters, the members of which are the survivals of the fittest in a thorough system of elimination by competition. Since they are now applying all of the knowledge of the atmosphere that has been revealed, little hope for material improvement in their work can be held out until a substantial addition is made to the pure science of the problem. This can only come through experimentation, study, and research. With 200 stations engaged in applying the science, it is a wise economy to devote at least one of them to the work of adding to the knowledge that we are annually spending nearly a million and a half of dollars to apply. Accordingly, we have endeavored to lay out a plan of study and research leading to an increase in our knowledge of the laws governing the atmosphere such as should eventually make it possible to add to the accuracy of weather forecasts and to make them for a longer period in advance.

The last thirty years has witnessed such remarkable progress in new branches of science that fields of research formerly closed to the meteorologist are now open to him and must not be neglected. Recent observations have led to the discovery of a possibly large variation in the amount of heat that is received from the sun or an equivalent possible variation in the transparency of the highest portions of the earth's atmosphere.

In such studies the Weather Bureau has hitherto taken a subordinate part, whereas in so-called practical meteorology it has always occupied the leading position.

The highest efficiency in any art requires a perfect knowledge of the higher science behind it. To establish law is necessarily antecedent to correct forecasts of rains, frosts, or storms.

MOUNT WEATHER RESEARCH OBSERVATORY.

Under the authority of Congress, three years ago, the Department undertook the establishment of a station at Mount Weather, Virginia, devoted to meteorological research, and has established there a plant especially adapted to atmospheric research. The temperature, moisture, and movements of the air at great heights will be ascertained by means of balloons and kites; the absorption of solar heat by the atmosphere will be measured; the dissipation of solar light and heat will be determined; the special analysis of the sunbeam will be carried out, and the electric condition will be determined. In addition to this we have added apparatus for studying the relations to the atmosphere of the magnetism of the earth, the temperature of the soil, and even the motions of the earth. All these phenomena have

been shown to have a more or less intimate connection with meteorology.

In so far as aerial research may require it, sounding balloons will be liberated from many of the weather stations in distant parts of the country in cooperation with those at Mount Weather, since it is considered very important to know the condition of the atmosphere above the land every day of the year up to the greatest attainable height, especially during the passage of storms and cold waves. Therefore, Mount Weather may be expected to do as much for the science of meteorology and the future improvement of the service as the service has already done during the past thirty-five years for the material interests of the United States. The employees at this station must necessarily live close by their apparatus, and provision must be made for all the ordinary needs of domestic life precisely as is done in all large astronomical observatories and in military establishments. This has been done economically and in accordance with established usage.

RIVER AND FLOOD SERVICE.

Neither the year 1904-5 nor its immediate predecessor was productive of serious floods in the larger rivers, although several damaging floods occurred in the smaller rivers, notably in the upper Sacramento in January, 1905; in the Purgatory and upper Arkansas rivers of Colorado; the Rio Grande, Pecos, and upper Canadian rivers during the latter part of September and the early part of October, 1904; and in the Grand River of Michigan in June, 1905. The floods in the rivers of the southwest in September and October, 1904, were peculiar in that they occurred in the semiarid region and at a time of the year when heavy rainfall is not anticipated. Their coming was not announced, since no flood service had yet been organized in that part of the country. The damage done by the floods in Colorado, New Mexico, Oklahoma and Indian Territories, and Texas amounted to at least \$4,000,000, of which the greatest share fell upon the railroads. The loss to the inhabitants was not less than \$1,000,000. These very destructive floods brought to the attention of the Weather Bureau the need of a flood service in the States mentioned. Such a service has therefore been organized, with 15 river and 10 rainfall stations, the headquarters of the district being at Denver. Although the service is not complete, it has done much good in giving warning of the floods in the Rio Grande during May and June, 1905.

The flood of June, 1905, in the Grand River of Michigan, while not as great as that of 1904, was nevertheless a disastrous one, and that it was not even more so was without question due to the forecast and warning service given by the Weather Bureau.

METEOROLOGY IN SCHOOLS.

The Weather Bureau has encouraged the study of meteorology in educational institutions by allowing its scientists, outside of their official duties, to deliver courses of lectures to students, so that there are now 20 institutions of learning where meteorology forms a part of the curriculum, thereby giving preliminary training to young men who, in after years, may succeed to the duties now performed by the meteorologists of the Government.

At every station of importance occupied by the Weather Bureau it is the custom for the official in charge to deliver such lectures as are desired by the public schools in his immediate neighborhood, and to instruct such classes as visit the offices of the Weather Bureau. In this way a general knowledge of the work of the Bureau is being disseminated in the community. During the past year several hundred such lectures have been given.

BUREAU OF ANIMAL INDUSTRY.

The work of the Bureau of Animal Industry is of great value to the country, and no part of it is of greater importance than the study and investigation of contagious animal diseases with a view to their prevention or control. In the war waged in the interest of stock raisers against contagious diseases the work of the Bureau of Animal Industry has been unremittingly carried on.

BLACKLEG.

In 1897 was begun an investigation for the immediate control of blackleg, or symptomatic anthrax. Losses from this disease were found to be very heavy in Texas, Indian Territory, Oklahoma, Kansas, Nebraska, Colorado, the Dakotas, and it was more or less prevalent in many other States. A series of experiments was made to determine the effect of vaccines, which were finally successful in developing a vaccine efficacious in producing immunity by a single vaccination. The preparation and distribution of this vaccine, with circulars giving methods for using it and containing a full account of the cause and nature of the disease, were undertaken on a large scale. Beginning with 355,000 doses distributed in 1898, the annual distribution was increased until it amounted to nearly 1,750,000 in 1903, with a little reduction since then, the distribution in 1905 amounting to 1,400,000. The effect has been to reduce losses from this disease from 10 to 12 per cent to about one-half of 1 per cent, and recent reports show that the dread disease is rapidly disappearing.

SWINE DISEASES.

In 1897 experiments were made looking to the control of infectious diseases of swine by administering a serum from animals inoculated, respectively, with the hog-cholera and the swine-plague germs. As

a result of these experiments and the stamping-out work undertaken in July of that year, 49 entire herds, aggregating 2,904 animals, had been destroyed and the pens disinfected by the end of the year. This work demonstrated that the losses might be promptly checked by the stamping-out method, but many farmers objected to these measures being carried out, and it was difficult so to enforce the regulations as to prevent the spread of the disease from farm to farm. Continued experiments with the serum treatment showed that there were cases known as hog cholera which did not yield to the treatment, and the very careful work of the Biochemic Division of the Bureau extending over several years has proved that acute hog cholera is caused by a virus which has not yet been cultivated and identified, but which passes through filters which will entirely remove both the hog-cholera and the swine-plague bacilli. The discovery of this hitherto unsuspected contagion has opened up an entirely new field of investigation, which is being energetically developed, and experiments are under progress which, it is hoped, will throw some light upon methods of prevention adapted to this disease.

TEXAS FEVER.

Investigations have been conducted to throw further light upon the microbe organism which causes the Texas fever. It was found that this organism was fostered in the blood of southern animals for as long, in certain cases, as twelve years or more after the removal of the animals from infected districts. It was found, however, that the animal retains its immunity three years after the disappearance of the microbe organism from its blood.

Another point of interest was to determine whether Texas fever ticks were capable of transmitting the disease to susceptible cattle at any time or only when they had recently absorbed blood of cattle from infected districts. It has been found possible to develop ticks in which the power of producing disease is absent. These ticks do not necessarily carry the Texas fever contagion, but obtain the germs of the disease from infected cattle. Other interesting experiments are now being conducted in connection with the subject with a view to acquiring a knowledge which will enable the Department to render more and more efficacious its control of this disease.

SHEEP SCAB.

Sheep scab has been one of the greatest obstacles to successful sheep raising, and the Department has experienced a great deal of difficulty in fighting it. Even after the order of June 18, 1897, was issued diseased sheep continued to arrive in large numbers at the principal markets. In 1898 a bulletin, entitled "Sheep Scab: Its

"Nature and Treatment," was issued, giving full information upon this subject and specifying the treatment by which the disease might be eradicated. This bulletin had remarkable influence in educating sheep raisers in checking the disease and in informing the public as to a possibility of curing infected animals. In July, 1899, an important order was issued describing the manner in which affected sheep should be dipped, instead of leaving this to the discretion of the owners and commission merchants. This order approved of the tobacco-and-sulphur and the lime-and-sulphur dips; formulas were given for their preparation, and the animals had to be dipped in one or the other before they were allowed shipment in interstate commerce.

While this action of the Department specifying dips to be used has been much criticized, it has proved a most important step toward the eradication of sheep scab. The number of sheep dipped under official supervision in 1899 was 672,944. The number increased after the year 1900 by leaps and bounds, nearly 17,000,000 having been dipped in 1905. At the same time it has been found that the dips become more and more efficacious. Reliable returns received in regard to 6,000,000 sheep in 1904 showed an effective percentage of 99.35. It is doubtful if such a measure of success has been achieved in any other country in treating animals for this disease. As the result of this work, sheep scab has almost or quite disappeared from several States that were badly infected and is much less prevalent in most others. By continuing the work and slightly increasing the number of inspectors for a few years it can undoubtedly be eradicated.

MALADIE DU COÏT.

An outbreak of *maladie du coït*, a venereal disease of horses, was discovered in Nebraska in 1898. The disease is a dangerous and insidious one, many of the affected animals showing but very slight symptoms, and yet being capable of transmitting it. While, therefore, in the earlier stages apparently mild, it may be very serious and even fatal, and its existence threatens the horse industry in any section where it gains a foothold. It was important to undertake the suppression of the disease promptly to prevent at any cost its spread to other sections of the country. In 1901 twelve diseased animals were destroyed.

The semiwild condition of the country through which the disease had spread and the prejudices of the horse owners and their lack of cooperation made it a difficult matter to discover diseased animals. Yet in 1902 there were 95 diseased animals slaughtered and 29 diseased stallions castrated. In 1903 there were 16,287 horses inspected, 511 diseased animals slaughtered, 277 suspected animals quarantined,

and 1,889 stallions castrated. An order was issued June 20, 1903, prohibiting the transportation of horses from the infected districts unless first inspected by an inspector of the Bureau, and the measures adopted in 1903 continued throughout 1904 and 1905, over 9,000 being inspected in the latter year without finding any actually diseased; also 23 suspected animals were slaughtered, and 9 stallions castrated. It appears from the investigations of the last year that the disease has been practically eradicated.

CATTLE MANGE.

The animals affected by mange were frequently found in important central markets, and accordingly a regulation was issued in June, 1903, prohibiting the shipment from one State to another of affected cattle, and making regulations for the inspection and certification of cattle from the infected districts, and the cleaning and disinfecting of cars. The number of cattle inspected under this order in 1904 was 1,124,321, and the number of dippings exceeded 157,000, and 535 infected cars were disinfected. The number of horses inspected for mange was 752; 453 were found diseased, and 138 were dipped. In 1905 the number of inspections of cattle was over 14,000,000, the number of dippings 563,394, and 29,897 cars were cleaned and disinfected. There were also inspected for mange 15,971 horses.

FOOT-AND-MOUTH DISEASE.

In the fall of 1902 there occurred an outbreak in New England of the foot-and-mouth disease, and arrangements were at once made with the authorities of the affected States—Massachusetts, Rhode Island, and Vermont—for the eradication of the disease. About 3,000 animals were known to be affected in December; the infected animals were placed under quarantine; a carefully selected force of inspectors organized, and arrangements were made for slaughtering the diseased herds and disinfecting the premises. Owing to the extreme cold and hard freeze, the work of disposing of the carcasses and disinfecting the premises was very difficult. In spite of this, the work was pushed energetically and the spread of the disease was promptly checked. In all, 244 herds, containing 4,712 cattle, were affected; 3,872 cattle were slaughtered, besides a number of hogs, sheep, and goats which had been exposed.

Over \$128,000 was paid in compensation for these animals. In the meantime the disease had spread somewhat extensively into New Hampshire, and thorough investigation was made of a considerable part of that State. It was found possible to remove the quarantine May 9, 1903, from Rhode Island, while the port of Boston, which had been closed to the exportation of animals during the outbreak, was reopened July 20, 1903, the quarantine of animals in Massachusetts

being removed the following October. It would be impossible to commend too highly the fidelity and energy with which the force of the Bureau carried on the work of eradication in spite of many difficulties. This campaign against a contagious animal disease stands unrivaled, if we consider the celerity, the economy, and the satisfactory results of the work.

TUBERCULOSIS.

Tuberculosis has been studied both as to its effects upon the animal industry of the country and as to the danger of its being communicated from animals to man. It is not uncommon to find herds of dairy cattle where 50 to 90 per cent of the animals are affected with this disease, and in our meat-inspection service there have been found in some large abattoirs nearly 3 per cent of hogs with tuberculosis. The disease, therefore, deserves the most careful study. The studies of the Bureau have been much helped by certain discoveries made by our own employees by which methods of investigation have been greatly improved. Experiments with monkeys showed that these animals are susceptible to both forms of the disease—bovine and human—and that there is little difference to be seen in the results of the infection with either. Careful observations soon indicated that with cattle the disease is more frequently contracted by taking in the bacilli with the inspired air than with the ingested food. A study was made of a herd of 102 cows, 76 of which showed reaction to the tuberculin test, to determine the infectiveness of milk from cows that had reacted to the test. As a result of this study the following conclusions were reached:

- (1) The tubercle bacillus may be demonstrated in milk from tuberculous cows when the udders show no perceptible evidence of disease, either macroscopically or microscopically.
- (2) The bacillus of tuberculosis may be excreted from such an udder in sufficient numbers to produce infection in experimental animals both by ingestion and inoculation.
- (3) In cows suffering from tuberculosis the udder may, therefore, become affected at any moment.
- (4) The presence of the tubercle bacillus in the milk of tuberculous cows is not constant, but varies from day to day.
- (5) Cows secreting virulent milk may be affected with tuberculosis to a degree that can be detected only by the tuberculin test.
- (6) The physical examination or general appearance of the animal can not fortell the infectiveness of the milk.
- (7) The milk of all cows which have reacted to the tuberculin test should be considered as suspicious, and should be subjected to sterilization before using.
- (8) Still better, tuberculous cows should not be used for general dairy purposes.

In a paper entitled "Danger of Infection with Tuberculosis by Different Kinds of Exposure," which gives the results of long and careful study of the subject, the following conclusions are presented:

The tendency of the results obtained from our experiments is to point to the conclusion that the presence of tubercular cows in a dairy herd is a danger which affects not only the health of the persons who use the milk, but also the prosperity of the owner of the cattle, and consequently that it is necessary, both for moral and economical reasons, that our dairy herds should be made free from tubercular animals as soon as possible. * * *

Too much stress can not be laid on the fact that tubercle bacilli are apparently more numerous in the environment of tubercular cattle than in their secretions from organs, like the udder, which have not become involved in the disease. Irrespective of the view that may be taken relative to the elimination of tubercle bacilli from the bodies of tubercular animals in their secretions from unaffected organs, it must be admitted that the chance for the introduction into these secretions, or into the secretions of healthy animals in the same environment, of infected material, such as particles of soiled forage or bedding, dust, masses of mucus which have adhered to the skin and hair, etc., is a very great danger, decidedly of too much importance to be ignored.

SURRA.

In 1901 a serious disease known as surra was found to exist among horses in the Philippines. Upon the request of the War Department for information on the subject an emergency report on this disease was at once prepared in the Bureau. There is reason to believe that the information thus made available has greatly assisted in the work of repression undertaken in those islands, besides aiding the inspectors of the Bureau in their efforts to keep out animals so infected. On account of this disease the Department has prohibited the landing of any animals from those islands at ports of the United States. Surra is very destructive in its effects on horses, and its introduction into the United States would be a great disaster.

TRICHINOSIS IN GERMANY.

In order to study this subject and to counteract statements continually made by the German press concerning American pork, an employee of the Bureau was sent to Berlin as an attaché of the American embassy to get a correct statement of available records bearing upon the subject. His report, published in 1901, is a clear exposition of the whole matter, and shows conclusively the harmlessness of the American pork shipped to Germany.

MEAT INSPECTION.

The subject of meat inspection grows in importance every year. It is not too much to assert that upon the success of this branch of our work depends a foreign trade worth many millions of dollars

yearly to our stock raisers. The meat-inspection law provides for an ante-mortem and a post-mortem inspection. It has increased steadily from year to year. In 1898 the total number of animals inspected before slaughter aggregated over 51,000,000; over 9,000,000 of them being cattle, 10,000,000 sheep, and 31,000,000 hogs. In 1905 the total number inspected aggregated nearly 66,000,000. At the same time it is important and interesting to know that the increase in the number of animals rejected was much less proportionately than the increase in the number inspected.

In 1898 the number of animals inspected after slaughter was 31,000,000, of which over 4,000,000 were cattle, 5,500,000 sheep, and 21,000,000 hogs. The total number inspected after slaughter in 1905 was something over 40,000,000. There were tagged with the label of inspection in the year 1905 nearly 22,000,000 quarters of beef, nearly 8,000,000 carcasses of mutton, 845,000 carcasses of veal, 1,000,000 carcasses and 800,000 sacks of pork. Meat-inspection stamps indicating the regular post-mortem inspection were affixed to 7,000,000 packages of beef in 1905, and to more than 15,000,000 packages of pork. The inspection of cars amounted in 1898 to 18,631, and in 1905 to 66,846. The number of live cattle inspected for export in 1905 was 824,914, of sheep 423,780, and of horses 2,358. In the same year 731 vessels which carried animals for export were inspected. The inspection of live animals at British ports by inspectors of the Bureau included in 1905, 401,623 cattle, 232,925 sheep, and 1,710 horses. Besides these inspections for our export trade, many thousands of inspections were made of imported animals.

NECESSITY OF ADEQUATE APPROPRIATION.

The importance of the cattle and meat inspection work of the Bureau of Animal Industry can not be exaggerated. It is only the certification, under the Government seal of the United States, as to the healthfulness of these products that enables us to place them in foreign markets. The withdrawal or even the restriction of our ability to supply such certification would mean the utter annihilation of our foreign trade in cattle and animal products. At the same time the Department is very much hampered by its inability to meet the demands for inspection for want of adequate appropriations. Requests for inspection—perfectly legitimate and having equal claims upon us with others already conceded—are constantly being received and continually increasing in number, so much so that even if the appropriations asked for for this Bureau last year had been allowed they would still have been inadequate to carry on the work. In the estimates submitted for next year these conditions are provided for, but it is only possible for the Department to carry on this important work adequately by the full compliance of Congress

with the estimates submitted for this purpose. If an emergency appropriation be not allowed and made immediately available, the Department will be compelled to abandon a large part of this important work. I deem it impossible to emphasize this situation too strongly.

ANIMAL NUTRITION.

The construction of a respiration calorimeter at Middletown, Conn., by Professors Atwater and Rosa for the study of human nutrition in cooperation with the Department suggested similar work with animals. Work along this line was authorized in June, 1898, to be conducted by Dr. H. B. Armsby, of the Pennsylvania Experiment Station, and his assistants. The calorimeter was constructed on the plans of the Atwater-Rosa apparatus, specially adapted for use with animals. Experiments were made on the available energy of timothy hay; later, of clover hay and maize meal. The work is now in progress, concluding with a study of the influence of age and individuality on the nutrition of animals.

ANIMAL HUSBANDRY.

An expert in animal husbandry was appointed July 1, 1901, and his attention was chiefly devoted to the investigation of questions of animal husbandry and to the practical or economic side of stock raising. July 1, 1904, an appropriation of \$25,000 became available for experiments in animal breeding and feeding in cooperation with the State stations, and this work was placed under the supervision of the expert in animal husbandry. Experiments have been begun in cooperation with the Colorado Experiment Station in breeding American carriage horses; with the Alabama Experiment Station in beef production; with the Maine Experiment Station in poultry breeding, and with the Maryland Experiment Station and the National Zoological Park in breeding zebra hybrids. A study has been begun on the fecundity of Poland China sows, with a view to determining whether sows of this breed have decreased in fecundity, and, if so, whether such decrease is chargeable to particular families. The effect of cotton seed and cotton-seed meal when fed to hogs is also under investigation. Several valuable publications on animal husbandry have already appeared.

ANGORA GOAT INDUSTRY.

The Bureau has aided the establishment of this industry in every way. The goats have been taken into every State and Territory, and reports of their success as mohair producers are numerous.

THE MILCH GOAT INDUSTRY.

Careful investigation of milch goats of European countries have been made and the results printed in a bulletin. The demand for this publication has been large, very many physicians applying for it. During the past year an expert was sent to Europe to investigate the industry in the leading goat countries, and an importation was made of 59 does, 4 bucks, and 5 kids of the Maltese breed. These animals are being employed in cooperation with the experiment stations at Storrs, Conn., and College Park, Md. At the former place cheese making has been undertaken and milk will be supplied to tuberculous patients and to children's hospitals; at the latter, milk will be furnished in Washington, D. C., to be used in the treatment of various diseases.

THE DAIRY INDUSTRY.

Dairying constitutes one of the main branches of animal industry. This line of agricultural effort in the United States yields good returns to a great number of producers. A large amount of capital is invested in dairying, and the development of the industry has been marked by the intelligence and enterprise of those engaged therein.

The interests of this industry have been looked after by the Dairy Division of the Bureau of Animal Industry. This Division was organized June 30, 1895, and during the past eight years its work has steadily expanded in scope, amount, and importance. At first its efforts were limited to the collection and dissemination of information regarding the dairy industry. Statistics and general information were collected and published; and bulletins were prepared describing the principal breeds of dairy cattle and outlining the most approved methods employed in the several branches of the dairy industry in this country and in Europe.

As time passed and larger funds became available new studies and original investigations were taken up. These included studies and investigations relating to the conditions and demands of domestic and foreign markets; the production of milk and its distribution to the people of cities; imitations of and substitutes for dairy products; and the number and distribution of pure-bred dairy cattle and grades, with their effect upon production and results.

WORK RELATING TO MILK.

Milk, an important product in its new state, and the basis for the manufacture of all other dairy products, has naturally received the first and largest share of attention. Popular bulletins have been prepared and issued in large and repeated editions, the object of which has been to raise the standard of production by educating both the

consumers and producers of milk. The most approved methods of feeding, handling, and milking dairy cows, and of cooling, handling, storing, and transporting milk have been presented, and the common errors and dangers involved in careless dairying forcibly pointed out.

WORK RELATING TO BUTTER.

The first work along this line consisted in a study, the results of which were reported in a paper entitled "Creameries or Butter Factories: Advantages, Location, Organization, and Equipment." The factory system of making butter was carefully investigated, and the methods of organizing, establishing, and conducting a creamery were outlined.

BUTTER EXPORTS.—Experimental exports of butter have received considerable attention. Special agents of the Department have visited Great Britain, France, Germany, China, Japan, and the Philippine Islands and arranged for experimental exports of butter to places in all. Trial shipments have been made to Germany, France, and England. The shipments to Manchester, England, have been most numerous and the most satisfactory, and a good reputation has been established for our butter in that quarter.

COLD STORAGE OF BUTTER.—To determine the best temperature at which to hold butter in storage, experiments were conducted in Chicago in 1903-4. The cream was collected and the butter made by the usual methods of a first-class creamery; the butter was put up in 60-pound tubs and stored at temperatures ranging from 5° F. below zero to 30° above zero. The results proved that a temperature a few degrees below zero is most desirable. The lot stored at 5° below kept almost perfectly for eight months, while the lots stored at 10° and 20° above zero deteriorated greatly.

RENOVATED BUTTER.—To the Dairy Division was assigned the duty of assisting in the administration of the act of Congress approved May 9, 1902, which authorized the Secretary of Agriculture to provide for inspecting the materials, factories, and processes employed in the manufacture of renovated butter, the object being to insure a sound and wholesome product and to see that renovated butter was labeled and marketed as such. This inspection work was assigned to nine inspectors located in commercial centers. The results have been very satisfactory. The character of the product of renovated-butter factories has been improved, and its price has become steadier; the total product of such factories has increased from 54,500,000 pounds in 1902-3 to 60,000,000 in 1904-5; and the law has not proven in any way detrimental to the makers of country butter, whose product forms the bulk of the stock worked up in such factories. In 1903-4 the inspectors of the Dairy Division reported inspections of 76 factories,

and visited the markets in 274 cities located in 44 States and Territories, to investigate and correct the conditions under which the renovated product was marketed. All renovated butter exported is inspected and certified by the dairy inspectors.

WORK RELATING TO CHEESE.

COLD CURING OF CHEESE.—In 1902-3 experiments were carried on in cooperation with the State experiment stations of New York and Wisconsin in the cold curing of cheese. In these experiments about 5½ tons of cheese were used, including all types of American cheese. Cheeses were cured at three temperatures, 40°, 50°, and 60° F. The commercial quality of the cured cheese was tested by a jury of experts. The advantage of curing at low temperature was established. More recently an important experiment has been made in the cold storing of cheese, and the results were quite similar to those secured in the cold-curing experiment.

EXPERIMENT WITH SOFT CHEESE.—An interesting experiment now in progress in cooperation with the agricultural experiment station at Storrs, Conn., relates to the manufacture in this country of soft cheese of the Brie and Camembert types, so largely made in western Europe. About 1,000,000 pounds of this kind of cheese are imported into this country annually. The object of this experiment is to ascertain the principles involved in the manufacture and to instruct the American farmers in the art, so that they can make these cheeses on their own farms.

WORK RELATING TO DAIRY CATTLE.

Realizing that the dairyman's success is so largely dependent on the character of his herd, the Dairy Division has given much attention to dairy cattle and has issued several publications on the subject. The object has been to improve the dairy stock of the country, and two lines of effort promising the largest measure of improvement have been kept continually before those engaged in the industry—(1) the increase of pure-bred stock of recognized dairy breeds, and (2) selection and breeding to secure cows of dairy type.

MISCELLANEOUS WORK OF THE DAIRY DIVISION.

STUDIES OF DAIRYING.—Representatives of the Division have gone into various sections of the country to study conditions as they exist and to report upon the actual development of dairy industries. Such work has resulted in the issue of several publications.

DAIRY STATISTICS.—This subject has received continued attention. Recently a compilation of the principal statistics relating to the

dairy industry in the United States was made and published, with maps and diagrams.

DAIRY LAWS AND ASSOCIATIONS.—A compilation of the laws of States and Territories relating to dairying, inspection, and adulteration of dairy products, etc., has been prepared and published. Circulars have also been issued annually giving a list of the officials and associations relating to dairying in the United States and Canada.

BUREAU OF PLANT INDUSTRY.

RESULTS ACCOMPLISHED DURING THE PAST EIGHT YEARS.

Plant investigations have been a feature of the Department's work since its establishment, although the organization of the Bureau of Plant Industry was not effected till July 1, 1901. It consists now of eleven offices, each of which is charged with the handling of a group of important plant problems. The work is carried on by 508 employees, about 60 per cent of whom are engaged in scientific work. The work of the Bureau is designed to bear directly on the practical questions which daily confront the tiller of the soil.

PROGRESS IN TREATING PLANT DISEASES.

Extensive investigations have been made in the treatment of plant diseases, with excellent results.

Peach-curl, a disease which occurs wherever the peach is grown, but is especially severe on the Pacific coast, has been brought under control. Experiments on the Pacific coast have resulted during one year alone in a saving of nearly a quarter of a million dollars' worth of fruit.

The little-peach disease, which at one time threatened the orchards of Michigan, New York, and other States, has been studied and its nature and method of control determined. The systematic destruction of the trees, under careful scientific inspection and regulations, is making possible rehabilitation of the peach fruit industry in a number of sections.

Pear blight has received special attention during the past six or eight years. Its nature has been thoroughly determined, and the methods of treatment recommended by the Department are now being followed by large pear growers in a number of parts of the country. Wherever the work of handling the disease is conducted systematically and scientifically, success has followed.

The Department has devoted special attention to the study of diseases of citrus fruits, recognizing the great value of this crop. A method of controlling wither-tip, orange blight, and sooty mold of citrus fruits has been developed and is now in actual use in a number of regions.

The cranberry crop of this country is valued at about \$2,000,000. Some years ago the crop was seriously threatened by a disease known as "scald." The Department's investigations resulted in the discovery of the cause of the disease and a method of prevention, thoroughly practicable, which is now in use.

Conservative estimates have placed the annual loss from bitter rot of apples in certain seasons, in the United States, at over \$10,000,000. This disease has been successfully treated by spraying. In the past season 90 per cent of the fruit in large orchards was saved, while in adjacent orchards, not treated, the loss was nearly complete.

A number of important crops, such as cabbage, turnips, etc., have from year to year been seriously troubled by certain forms of bacterial diseases. These diseases have been studied, their natures determined, and in most cases remedies developed and put into practical use.

Some destructive diseases of the most important agricultural crops of the South, notably cotton, the cowpea, and the watermelon, have been studied and remedies found for them. One of the most serious diseases of cotton, which for years caused great loss, was wilt. This trouble was especially destructive in the Sea Island districts. Careful scientific investigations showed the cause of the disease to be a minute fungus working in the roots, and it was further shown that certain plants were able to resist this fungus. Selection of seed from year to year from these plants has resulted in the establishment of resistant types. At the same time that resistance was being developed it was necessary to maintain the value of the types in other directions, notably in lint production, length of fiber, etc. This has all been done.

Cowpeas, which are used extensively in rotation with cotton, are also subject to the same disease, and it therefore became necessary to secure resistant varieties of this crop. This has been accomplished.

The great importance of intensive horticultural work has been fully recognized by the Bureau of Plant Industry in the study of plant diseases. Plants grown under glass are necessarily subject to a number of serious troubles. The Bermuda lily, a very important crop, has for years been subject to a disease which investigations have shown is primarily due to improper methods of cultivation. Methods of avoiding these troubles have been developed by the Department, and in most cases the disease may now be successfully controlled.

Diseases of the violet, the calla lily, the carnation, and other crops have been studied, and important discoveries in reference to their causes and control have been announced.

One of the most important lines of investigation conducted by this Bureau during the past eight years, in cooperation with the Forest Service, has had to do with a study of the decay of construction

timber and methods of preventing such decay. This work has resulted in improved methods of handling construction timbers and impregnating them with protective substances. Only recently a cheap and effective method of treating fence posts has been discovered.

Within the past few years a serious disease appearing in the rice fields of South Carolina has threatened a most important industry of the State. Investigations of this disease, made in cooperation with the South Carolina Experiment Station, have resulted in the discovery of the cause of the disease and a comparatively simple remedy therefor.

AGRICULTURAL EXPLORATIONS.

Systematic work in securing new plants and seeds from foreign countries for introduction into the United States was inaugurated in 1897. Remote parts of the world have been searched by agricultural explorers for new crops, and valuable additions to our agricultural productions have been made. The aim of our agricultural explorers has been to seek living seeds and plants in quantity for extensive trial throughout the country. Their explorations have included the desert regions of Asia and Africa, the sub-Arctic regions of Russia, Norway, and Sweden, the climatically east-American regions of China and Japan, the tropical regions of the Dutch East Indies, the Pacific islands and Central America, and the Australian, South American, and South African regions of the southern hemisphere.

Our explorers have brought back large numbers of useful plants, which have been distributed to carefully selected experimenters. Among these is a new alfalfa, more resistant to drought and alkali than our common species. This was introduced from Turkestan, and is proving successful in the West.

The largest collection of date-palm varieties in the world has been secured and established in the Colorado River region of California and Arizona, and numbers of these imported palms have already borne fruit of good quality, proving the possibilities of date culture in that region. The largest collection of mangoes in the world, comprising the best varieties known, has been gathered from different parts of the Tropics and is now being distributed in Florida, Porto Rico, and Hawaii.

Long-staple Egyptian cottons have been introduced and used in the production of new hybrid types. These hybrid types already promise considerable value.

The best malting barley in Europe, the Hanna, has proven remarkably successful in the barley-growing sections of the Pacific slope and will be thoroughly tested.

The hard-shelled almond of Spain, heretofore unknown to our growers, has been introduced successfully in California.

Large shipments of the hardy timber bamboos from Japan have been introduced and planted in the Gulf States and in California.

The pistache, which is a promising dry-land nut for regions where the almond fails, has been introduced in large quantities, and arrangements for its propagation and dissemination in the Southwest have been made.

ACHIEVEMENTS IN COTTON BREEDING.

In the breeding and improvement of cotton the first experiments of the Department were begun in 1899. At this time little had been published regarding cotton breeding. Careful methods of breeding were devised and methods of judging cottons by score cards worked out, which have become standards for work in this field of investigation. The frequency of natural crossing in the field was studied, so that different varieties might be grown without risk of mixing and deterioration. The correlation of characters, the laws governing the splitting up of hybrids, the form of plant, and other important matters have been carefully studied. Reliable advice can now be given to cotton seed-growers and breeders.

A most important problem in the cotton industry is the securing of varieties as productive as the ordinary staple sorts but producing longer and better lint. This can be done by two distinctly different methods.

The first method is to secure hybrids of the long-staple Sea Island cotton with the standard short staples, with a view to obtaining new sorts which combine (1) improved length of staple with the large bolls, opening well, and (2) the productive character of plant of the short staple. Many thousands of such hybrids have been made and carefully tested in the course of the Department's experiments, and three new sorts have been secured which possess distinctly valuable characters and are believed to be worthy of general propagation. These have been carefully bred until they are now nearly as uniform in type as the standard varieties, but require to be carefully selected for one or two more generations before they are generally distributed to planters. One of these hybrids, which is a distinctly Upland type of plant and produces large round 5-locked bolls, has fine silky lint from $1\frac{1}{2}$ to $1\frac{5}{8}$ inches in length and a smooth black seed, so that it may be easily ginned on roller gins if desired. The fiber of this variety will rival the Egyptian and lower grades of Sea Island. The other two varieties are similar, but have lint averaging only about $1\frac{3}{8}$ inches.

A second method of securing improved staple, which has given very striking results, is the straight selection of the standard short-

staple varieties. It was found by careful examination of such varieties as Russell and Jones Improved, which are both excellent standard sorts, that there was considerable variation in the length of lint produced by different plants. Careful selection experiments have been conducted with both of these varieties, and the average length of lint in the breeding stock of these two varieties has been increased from the ordinary 1 to 1½ inches until it is now from 1¼ to 1¾ inches; meanwhile the plants have maintained their full productiveness and all other good characters. These varieties, now clearly distinct from the original stock, should be propagated and placed with growers as rapidly as possible. King cotton, which has been so extensively recommended for cultivation in boll-weevil districts, but which has been condemned because of its poor lint qualities, has also shown itself capable of great improvement in the same manner.

All varieties of cotton have been found to vary greatly in their productivity in the case of different individuals and different strains of the same variety. One strain of Pride of Georgia, which for several years has been selected for increased yield by a careful system of pedigree breeding, has shown marked improvement. A considerable quantity of this seed will be distributed to planters in the spring of 1906, and in 1907 a still higher grade of select seed of the same variety will be available.

In the boll-weevil infested area there is great demand for earlier varieties of big-boll types. The extensive experiments inaugurated in 1904 on this subject have not yet reached a stage where safe conclusions can be drawn, but preliminary experiments started the year preceding have given one very early strain, selected from a native Texas big-boll sort, which has proven very productive and is considerably earlier than the big-boll sorts with which it has been compared. A limited trial distribution of the seed of this variety will be made in the spring of 1906.

A large quantity of Egyptian cotton is imported into this country annually and used in our mills. It seemed probable that with our extensive cotton area some soil and climate could be found where this cotton could be successfully grown. Experiments were conducted in various parts of the country and careful manufacturing tests were made with the fiber. These experiments have shown conclusively that we can in many places produce an excellent quality of fiber, possessing all the characteristics of the best Egyptian-grown fiber. The yield in most places, however, has been so low that these cottons can not compete with the ordinary Uplands. If they are to succeed, more productive and earlier sorts will have to be bred, or the cultivation will have to be conducted in the extreme southern part of the cotton belt, where there is a very long growing season.

MEETING THE RAVAGES OF THE COTTON BOLL WEEVIL.

As the spread of the cotton boll weevil extended north and east in Texas it became evident that there were problems connected with the invasion of this pest other than those purely entomological. The invasion of the weevil necessitated, in many cases, a complete revolution in agricultural practices. The Bureau of Plant Industry, in order to meet this exigency, has had for the past two years a corps of workers in the field carrying on important investigations in the matter of breeding new types of cotton better adapted to the conditions which have arisen since the invasion of the weevil. It has been conducting demonstration work to point out and emphasize the value of the discoveries which have been made by the Bureau of Entomology and other branches of the Department and to encourage diversification of crops. It has been searching the cotton regions of this and other countries in the hope of discovering types of cotton better suited to the new conditions in the invaded territory. In connection with this work some important discoveries have been made in the matter of types of cotton which have, through a long series of years, been able to adapt themselves to the presence of the weevil.

The most important work, however, in this connection, has been the field demonstration work which has had for its object the bringing home to the people themselves practical methods of tillage, cultivation, and planting to enable them to grow cotton despite the presence of the weevil. This general demonstration work has been pushed energetically in Texas and also extended into Louisiana in advance of the insect.

NEW CITRUS FRUITS PRODUCED BY THE DEPARTMENT.

The two great freezes of the winter of 1894 and 1895, which killed to the ground practically every orange and lemon tree in Florida except in the extreme southern part of the State, served to emphasize the great importance of securing hardy varieties of these fruits. Experiments were started by the Department, and the results which have been obtained are very valuable and encouraging. It has been shown that valuable hardy races can be produced by crossing the very hardy cold-resisting trifoliate orange with the different varieties of the ordinary sweet orange. Two of these hybrids which were found to produce valuable fruits were propagated, and in the spring of 1905 distributed broadcast to interested growers in South Carolina, Georgia, Alabama, Louisiana, southern Tennessee and Arkansas, eastern and southern Texas, and regions of low altitude in Arizona, New Mexico, Washington, and Oregon. These fruits, being different from any known group of citrus fruits, were named citranges, and the two

varieties distributed were named, respectively, the "Rusk" and the "Willits."

The Rusk citrange is a beautiful, smooth, round fruit, with a reddish flush, being very similar in size and appearance to the tangerine. It makes a good citrangeade, similar to lemonade, and is especially valuable to use for culinary purposes. The Willits citrange is more like a lemon in appearance and quality; it is to be recommended for use in making citrangeade, pies, etc., and may be served on occasion in the place of lemons. Both the Rusk and the Willits citranges are nearly seedless.

Four other varieties of hardy oranges, or citranges, have been obtained, each possessing special features of merit. One of these produces a fruit so similar in size and appearance to the ordinary orange that it can only be distinguished by an expert. This fruit has been named the Morton. The Morton citrange produces an exceedingly juicy fruit, of fine texture, which is almost totally seedless. As in the case of the Rusk and Willits citranges, it makes a delightful citrangeade and can be used for culinary purposes. Trees of this variety will be distributed to growers in the spring of 1906.

Another variety, similar to the Morton in appearance, but differing in flavor and tree characters, is also believed to be valuable and will be propagated for distribution as soon as possible.

A special feature of these hybrids is their fine foliage characters, which adapt them to propagation as lawn trees and as hedge plants. Some of the hybrid oranges are far superior in general adaptability to the trifoliate oranges often grown for this purpose, having much denser and handsomer foliage, and being largely evergreen, retaining the greater part of their foliage throughout the winter. The Rusk and Willits citranges and the two varieties last mentioned, however, are hardly satisfactory to use for general hedge purposes, as they are nearly seedless and would require to be propagated by budding. Fortunately, two hybrids have been secured which have the desirable hedge characters and have thus far produced an abundance of seeds, indicating that they will be very desirable for use in this way. These two varieties will be tested as hedge plants and distributed if they continue to form numerous seeds, which will allow of their easy and cheap propagation.

In the course of the experiments two new tangerines have been produced, which have been named the "Weshart" and the "Trimble." These produce fruits considerably larger than the ordinary tangerine and are nearly two weeks earlier in season—two very desirable characters. These varieties have been propagated as rapidly as possible, and a limited distribution of budded trees will be made.

One of the most interesting of the Department's productions is the new tangelo. This fruit, a hybrid of the pomelo with the tangerine,

may be described as a small, loose-skinned ("kid-glove") pomelo. It has a good sprightly acid flavor, which it is believed will render it a popular fruit. It has been named the "Sampson," and a limited distribution of stock will be made next spring.

One very excellent variety of sweet orange has been secured, which will probably be propagated and introduced. It is a large, round blood orange, nearly seedless.

Within recent years the lime has become an important commercial fruit, but as yet the trees grown are mainly seedlings and the fruits are very variable in shape, size, and quality. Some markets are coming to demand fruits of a certain size, and it is desirable that growers should plant varieties of known characters. Two new seedlings producing fruit uniform in size and of good quality have been secured in the Department's experiments; these will receive names and will be distributed in lime-growing regions. One of these produces a small fruit and the other a large fruit. In both cases the fruit is produced mainly near the exterior of the tree, which is a character of importance, as it greatly facilitates the harvesting.

NEW PINEAPPLES PRODUCED BY THE DEPARTMENT.

The so-called fancy varieties of pineapples grown and tested in the United States have as a whole proved unsatisfactory, so that their cultivation has been largely abandoned for the cultivation of the inferior but more robust and hardy varieties, such as the Red Spanish. It is thus desirable that varieties of better fruit qualities be secured, which at the same time will have a vigorous, hardy constitution, adapting them to general cultivation. To secure such improved sorts many hybrids have been made by the Department, the experiments having been started mainly in 1896 and 1897. These have as a whole produced fruits of exceptionally good quality. Many smooth, spineless-leaved sorts have also been produced, and as only one smooth-leaved sort is now cultivated in Florida some of these varieties will doubtless prove of considerable value. Five new varieties have been sufficiently tested to demonstrate their value, and these have been named and will be distributed to planters as soon as sufficient stock can be propagated. A number of other varieties of promise have been secured, some of which will doubtless prove to be of value.

WORK ON NITROGEN FIXATION.

The great value of leguminous crops for forage and as soil improvers, especially in their ability under certain conditions to fix atmospheric nitrogen, led this Department in 1899 to undertake a study of the Old World legumes with a view to introducing into the United States such as promised to be valuable in regions not now

well supplied with these crops. Early in this work it became evident that we must also introduce the tubercle bacteria, especially for those species of legumes not having closely related species in cultivation in the United States. During the following three years a large number of introductions of these crops was made, and in all cases where it seemed desirable root samples containing tubercles were also secured. The isolation and distribution of these nodule-forming bacteria, with their appropriate crops, was believed to be one of the prime factors in their successful introduction. The common practice of inoculating leguminous crops by the use of soil which was known to contain the proper bacteria was not only expensive, especially where the soil had to be transported for long distances, but was fraught with great danger of introducing noxious weeds, plant diseases, and insects. An investigation was therefore made of the method proposed by Nobbe and Hiltner, of Germany, for inoculation by the use of pure cultures under the name of "nitragin." It was found that these cultures had been tested very carefully in this country and in Europe and had proven unsatisfactory.

In the course of the investigations, moreover, it was soon found that the pure-culture method, as then practiced, was a failure, owing to the fact that the bacteria were cultivated artificially on a substratum rich in nitrogen, thus obtaining all of the nitrogen they desired for growth direct from their food supply without depending upon the atmosphere for it. It was found that as soon as the nitrogen was removed and the bacteria were required to depend upon the atmosphere for their supply of nitrogen it was possible to secure strains of bacteria with greatly increased nitrogen-fixing power. It was further found that these bacteria thus secured could be dried on an absorbent medium like cotton, retaining their vitality undiminished.

Extensive tests of this method of culture and distribution were made in the laboratory and field during 1902 and 1903. These tests under careful scientific control were so successful and the method was simplified so greatly that it seemed desirable to give it a careful test in the hands of practical farmers. It was believed that a method to be of any value should be simple enough to be used by an intelligent farmer. As a result of a general distribution of cultures in the latter part of 1903 and in the spring of 1904, it is evident that the method of distribution perfected by the Department has great advantages over any other method of soil inoculation yet devised. While there is much yet to be done in determining the conditions under which the use of these tubercle-forming bacteria will give the most favorable results, it is evident that we have a very successful method of growing and distributing them and increasing their nitrogen-fixing powers. No new development of this kind can be successful in the hands of everybody. Failure may come from many causes.

Usually these causes are easily determined and corrected. Sometimes they are obscure and must be carefully investigated in order to be determined. On the whole, however, the intelligent farmer is able to use the cultures under favorable conditions with success and profit.

WORK ON WATER CONTAMINATION.

In 1902, under authority from Congress, this Department began an investigation of algal and bacterial contaminations of water supplies. Some preliminary tests made in 1901 in removing algae from cress beds were so successful that it seemed desirable to test the method under a wider range of conditions. Although sand filtration in the case of water supplies for domestic use had proved successful in removing bacterial contamination, it failed completely in the matter of algal organisms that give disagreeable tastes and odors to water in which the algae occur. Extensive tests were made in the laboratory during 1902 and 1903, and also in large reservoirs and other water supplies in various parts of the country. The results of these tests were first published in May, 1904. In this report it was shown that minute traces of copper, so small as to be entirely harmless to man and to the higher animals (and even to fish, if properly used), would successfully destroy not only contaminating algae but also bacteria of the typhoid and cholera groups. The method has been further tested in cooperation with boards of health and water engineers in many parts of the country during the past two years, and in nearly every case where the work has been done according to directions of the Department it has resulted successfully. Many intelligent boards of health and water engineers are recognizing the value of the method when used under proper conditions.

TOBACCO WORK.

A special feature has been made of tobacco investigations during the past eight years. One of the most important lines of investigation which was undertaken and completed was a study of the causes of fermentation in tobacco. Before this work was begun the underlying principles governing fermentation were not understood. In fact, the cause was not known, it being attributed by some investigators to living organisms and by others to various causes. A careful scientific physiological study of the subject resulted in the discovery that fermentation is due to the action of certain enzymes. In the light of this discovery it became practicable to make many new suggestions in regard to a better handling of tobacco.

Another important line of work has been a study of the types of tobacco, with a view to securing uniformity and the improvement of existing forms by breeding and selection. Large sums of money

have been spent in attempts to introduce seed of foreign types of tobacco into this country and to grow these types in such a manner that the plants would be uniform, but with unsatisfactory results until the discovery was made that to secure uniformity in types, careful attention must be paid to the development of the seed, especially in the matter of the pollination of the flowers. This work has shown the practicability of developing in a few years uniform types of tobacco, which will make possible the growing in this country of types which are now largely imported, such as Sumatra, the Havana filler, and other forms. The work has furthermore shown the great possibilities of securing new types by crossing. The discovery of the means of fixing these types has greatly improved the prospects of the entire industry.

ADVANCES IN GRASS AND FORAGE PLANT INVESTIGATIONS.

The Department has made considerable progress in grass and forage plant investigations. Largely through its efforts, alfalfa has been thoroughly established in almost every State, including the Eastern States. The new Turkestan variety, introduced by our explorers, has proved to be of special value for the Northwest and other cold, dry sections.

Methods of restoring denuded ranges and maintaining a productive condition have been worked out. Several spineless varieties of cactus have been introduced from Mexico, the value of this plant as a forage crop having been demonstrated.

It has been found possible to control drifting sand by vegetation, and valuable results have been secured in covering railroad embankments and cuts with plant growth.

Cowpeas, soy beans, and new varieties of sorghum have all been effectively studied, and their growth extended. Several new varieties have been studied, and their value for hay and pasture demonstrated. A number of wild grasses have been introduced into cultivation. As a winter pasture and forage for the South the hairy vetch has assumed importance. A cheap and complete method of eradicating Johnson grass, which is probably the worst weed in the United States, has been worked out.

BETTER SEEDS FOR THE FARMER.

Methods and apparatus for testing seeds for mechanical purity and germination have been studied and perfected. By means of publications giving descriptions and drawings of weed seeds and the seed of our economic plants, farmers have been warned of the adulterants frequently found in field seeds and have been advised as to the general quality of those in the trade. They have been invited, in all cases

of doubt, to submit samples to the Department for testing before buying.

Through samples of imported seed received from the custom-houses, information has been obtained as to the quality and kinds of seed being imported both for legitimate use and for purposes of adulteration.

The proper conditions for the storage of seeds under unfavorable climatic conditions have been determined. The handling of Kentucky blue grass has been studied and the proper treatment to economically produce seed of high vitality has been pointed out.

IMPORTANT RESULTS IN GRAIN INVESTIGATIONS.

DURUM WHEAT.—Durum wheat was first introduced from east and south Russia in the spring of 1899. During the next year a much larger quantity of seed was imported, including varieties from North Africa. In 1901 there were produced probably 50,000 bushels of durum wheat. The following year there appear to have been grown considerably over 1,000,000 bushels. The production has steadily increased until in the season of 1905 it is conservatively estimated by grain dealers to be between twelve and fifteen million bushels for the three States of North Dakota, South Dakota, and Minnesota. Add to this about 5,000,000 bushels for Kansas, Nebraska, Colorado, and the Rocky Mountain and Pacific Coast States, and the result is a production of probably 20,000,000 bushels for the entire country.

Among many advantages claimed for this new crop are the following: It is well adapted to dry regions and to considerable areas where other kinds of wheat will not succeed. Even in those portions of the semiarid districts where other wheat can be grown the yield per acre of durum wheat exceeds that of the former by 30 to 100 per cent. Its average rust resistance is very much greater than that of common sorts. The experience of the semolina manufacturers of Europe is that the best macaroni can be made only from this kind of wheat. Durum wheat makes at least as good bread as any other wheat, and such bread is preferred by a large majority of consumers. Moreover, durum wheat bread remains fresh longer. The percentage of flour per bushel from durum wheat is greater than that produced from the best of other varieties and the sugar content of the bread much greater than that of bread from other flour.

It is reported that during October about 6,000,000 bushels of durum wheat were shipped to Europe and that the prices recently offered by importers were an advance of 12 cents over the price paid for the first shipments. The question of marketing the wheat, therefore, can no longer be a doubtful one, as our reputation for furnishing a good quality of grain is well established. As stated

recently by an official of the board of trade of Duluth, durum wheat has "passed the experimental stage and is now a regular commodity."

SWEDISH SELECT OAT.—Another valuable new crop is a variety of oat known as "Swedish Select," introduced in the spring of 1899. This oat is a pedigreed variety, developed many years ago in Sweden and afterward thoroughly acclimated in the cold region of northern Russia. It is admirably adapted to our Northern States, and long ago became the most popular oat throughout the region from Wisconsin to Montana. The production has increased each year, and at least 4,000,000 bushels were grown this season. It is a vigorous white oat, weighs heavily, and is considerably resistant to drought. The yield per acre is generally better than that of any other variety tested in comparison in the Northern States.

SIXTY-DAY OAT.—This variety of oat was introduced from southwestern Russia four years ago, and is now giving results in the territory of the Middle West comparable to those obtained with the Swedish Select in the North. Being much earlier than ordinary oats, it is able to escape rust and other fungous and insect pests in seasons when other varieties are badly affected. For the same reason it also sometimes escapes the worst stage of a drought.

EXTENSION OF THE WINTER-GRAIN AREA.—One of the most important things in grain cultivation is to be able to grow fall-sown crops, as both the yield and quality of a winter grain are invariably better than those of spring grain in the same locality. A valuable achievement of the Department in this line is the successful introduction of winter barley, known as "Tennessee Winter," into northern latitudes. This barley is now thoroughly acclimated as far north as Kansas and gives yields so much greater than those of spring barleys and is so important on certain occasions for winter pasturage that it is causing little less than a revolution in grain cultivation in a number of localities.

Two Algerian barleys have been introduced with much success in the Southwest. They are thoroughly adapted to desert conditions and alkali soils and have so far given yields per acre that are from 50 to 80 per cent greater than those of other varieties in the region between Texas and southern California.

In the grain experiments carried on in cooperation with the Maryland Experiment Station it has been discovered that there are a number of important varieties of two-rowed hull-less and other kinds of barleys that are perfectly hardy when sown in the fall.

The winter-wheat area is being extended north and west, largely through the introduction of the Kharkof winter wheat, which has become almost as popular as the Swedish Select oat. It is closely allied to the well-known Kansas Turkey wheat, but is hardier both

for the winter and in seasons of drought. The winter-wheat area has already been extended almost entirely over the State of Nebraska, to a considerable extent in Minnesota, and to a lesser extent in South Dakota.

OTHER CEREALS.—One of the most valuable cereals for feeding to sheep, hogs, and chickens is the Russian proso, or broom-corn millet. Several varieties of this cereal were introduced from Russia in 1899, at least two being more drought-resistant and otherwise better adapted to the Northwestern States than any varieties of this millet heretofore grown in this country. It is particularly adapted for sheep feeding.

Better varieties of emmer (often called spelt) have also been established by the Department in the semiarid districts. This crop also resists drought to a great degree, and certain varieties resist rust as well. The winter variety is as hardy as the hardiest winter wheats. The emmer and proso together afford an immense amount of grain and straw for stock feeding in dry localities, where very little feed of any other kind can be produced.

ENCOURAGEMENT OF RICE PRODUCTION.

Rice has received special attention during the past six or seven years. The Japanese, or Kiushu, variety was brought into the country and disseminated. Since this introduction the development of the rice industry in the South has been phenomenal. Between 1899 and 1904 the rice acreage of Louisiana and Texas increased from 210,396 acres, yielding 179,919,293 pounds of rough rice, in 1899 to 610,700 acres in 1904, yielding 869,426,800 pounds, an increase of upward of 190 per cent in acreage, by far the greater increase being in Texas. In 1889 Texas had 178 acres of rice, in 1899, 8,711 acres, while in 1904 the acreage had increased to 376,500, or more than forty-three times the area under this crop six years ago.

PROGRESS IN THE BEET-SUGAR INDUSTRY.

In 1897 there were but nine beet-sugar factories in the country, and the total amount of sugar manufactured was 30,000 short tons. A great change has since taken place, and the estimated output for 1905 is 280,000 short tons.

Extensive practical demonstrations carried on throughout the sugar-beet belt have clearly and positively proved that if the farmers will properly prepare and fertilize the soil, sow a high grade of seed, cultivate and care for the growing crop, and treat it for diseases and insects in accordance with the methods recommended by the Department, not only will their yield be increased but their beets will be of

better quality and higher sugar content, while the cost of their production will be materially decreased.

The failure of more than one factory has been due to the use of poor seed, and the establishment of high grades of seed has been one of the most difficult problems with which we have had to contend. The Department has, however, within the last year or two, succeeded in establishing farms in sections of the United States where the climate and soil conditions are favorable for the supply of pedigreed seed of superior quality.

Last year one of the largest growers of this seed had to refuse more than 50 per cent of his orders on account of his inability to grow a sufficient quantity of seed. These results warrant the assertion that within the next few years the quantity of seed grown in the United States will not only greatly exceed that grown heretofore, but by its use beet-sugar factories will greatly increase their percentage of sugar extraction. The fact that an increase of 1 per cent in the sugar extraction for last year would have increased the output of refined sugar by more than 40,000,000 pounds is in itself sufficient reason to warrant the Department in exerting every energy to continue the encouragement and assistance it has given to sugar-beet seed growers.

The work the Department has undertaken in establishing single-germ beet seed has proved eminently satisfactory, and it is now assured that a high-grade strain of single-germ seed can be produced, which will greatly reduce the cost of thinning. This will mean the saving of thousands of dollars to farmers throughout the sugar-beet belt, and will give a new impetus to sugar-beet growing.

The yield of sugar beets has been greatly increased not only by scientific cultivation, but by the judicious use of fertilizers, which in some cases have increased the yield from 40 to 50 per cent, and at the same time improved the quality of the beets.

THE ARLINGTON FARM AND GENERAL HORTICULTURAL WORK.

Within the past four years an important increase in the facilities for the work of the Department has been made through the addition of the Arlington Farm. This farm is located near the Arlington Cemetery and contains 400 acres.

From a neglected area overgrown by brush and weeds the farm has been converted into a suitable tract for field and demonstration experiments. Sections are devoted to a nursery, in which the orchard and ornamental plants to be used upon the farm are propagated; a peach orchard of 250 varieties has been planted; an apple orchard of 400 sorts has already been established, and a mixed orchard for experimenting upon the control of orchard diseases has been provided, as well as an orchard for the study of the habits and methods

of controlling injurious insects. Another orchard has been set aside for testing the effects of cover crops upon the growth and fruiting period of trees. A demonstration fruit garden, a demonstration vegetable garden, and a grass garden have also been features of the farm for three years. Areas are set aside for the growing and testing of forage crops; also for the growing and testing of forest trees, osier willows, and other plants by the Forest Service, various plants and crops for the Bureau of Entomology, and various crops for use of the Bureau of Soils, etc.

A special feature has been made of truck crops in the South. Numerous improvements in the matter of equipment so far as concerns the glass houses on the Department grounds have also been brought about within the past three or four years.

RECENTLY ESTABLISHED FACTS IN TROPICAL AGRICULTURE.

A special branch of the Bureau of Plant Industry has devoted a large part of its attention to various crops suitable for the Tropics.

Coffee has received special study in Porto Rico. Studies of coffee in other regions have been made with a view to profiting by the results obtained in those regions. Several of the supposed principles of coffee culture have been found, on being subjected to scientific study, to have only local application. It has been shown that the value of shade, which is recognized in a number of coffee-growing sections, is due primarily to the fact that the shade trees are of the leguminous family.

Important investigations have been made of the rubber industry in Central America. These studies have developed two important facts: First, that the rubber tree does not require to be grown in regions of great and continuous humidity, as heretofore believed, but thrives and produces better in districts subject to a distinct dry season. The second important fact is that, contrary to previous popular and scientific opinion, the same species of rubber does not extend throughout the Central American region. The reports which the Department has published have served as a warning to the public of the essentially uncertain character of a number of undertakings in rubber culture and have undoubtedly saved to the American public millions of dollars.

Cacao is another crop which has received special study. The cultivation of this crop is confined almost entirely to humid localities, in accordance with the belief that such a climate is necessary to the welfare of the tree. This belief is erroneous, and it is expected that with better cultural methods the growing of this important crop will become an established industry in all the tropical possessions of the United States.

Millions of dollars are paid annually by this country for tropical products grown outside of our territory. The efforts of the Department have been in the direction of encouraging the production of these crops, as already indicated, in our own tropical dependencies.

ADVANCES IN POMOLOGICAL INVESTIGATIONS.

Along the line of pomological work much of immediate practical value to fruit growers and handlers has been accomplished. Thousands of specimens of fruits forwarded by growers for identification have been passed upon by the pomologist and his expert assistants.

A fairly comprehensive test of a large number of *vinifera* grapes on resistant stocks in North Carolina and Florida has demonstrated that certain choice sorts of this type hitherto considered impossible of cultivation in the open air in the South Atlantic States can be successfully grown for home use, at least, when grafted upon such stocks and when thoroughly sprayed to protect against fungous diseases. A systematic and comprehensive experimental investigation of the relative adaptability of resistant stocks to the various soil types of the Pacific slope and of the relative congeniality of the important commercial *vinifera* varieties to these stocks is in progress in California. The continued prosperity of the viticultural industry of the Pacific coast, in which over \$85,000,000 is now invested, depends in large degree upon the accurate determination of these important questions.

In recognition of the fact that the avoidance of disastrous gluts in our markets is one of the most important factors in developing and maintaining a thrifty fruit industry, special attention has for several years been paid to the encouragement of export trade in American fruits and the improvement of methods and practice in fruit storage and transportation. Comprehensive experimental investigations to determine the best methods of harvesting, packing, handling, and transporting such fruits as are most promising for export have been conducted. Through cooperative experimental export shipments during the last four seasons it has been demonstrated that eastern-grown "Bartlett" pears can be successfully and profitably exported in seasons when the European crop situation justifies the effort.

A large and rapidly developing export trade in eastern-grown "Bartlett" and other autumn pears has developed along the lines pointed out by these experiments. It has been further demonstrated that early varieties of apples from the Middle Atlantic States can be delivered in British markets in excellent condition when proper precautions as to harvesting, packing, and forwarding are observed; also that "Elberta" peaches from Georgia, Oklahoma, and Connec-

ticut, and later varieties of this fruit from the mountain orchards of Virginia and West Virginia, can be delivered in the United Kingdom in sound and attractive condition whenever the market conditions warrant. It is believed that the establishment of these facts has laid the foundation for a normal and thrifty development of a profitable future export trade in these fruits.

When the Bureau of Plant Industry began the fruit transportation and storage investigations there was little exact information concerning the factors that influence the shipping and keeping qualities of fruits. Very serious losses occur in transit in small fruits and in fruits such as the peach and the orange, as well as in fruit in cold storage. It has not been known whether these losses are due to the cultural treatment, to the methods of handling the fruit, or to the conditions surrounding the fruit in transit and in warehouses. There have been much litigation and many misunderstandings over these difficulties. The Bureau of Plant Industry has succeeded in establishing some of the fundamental factors that govern these questions. It has applied the results to the commercial fruit business of the country in such a way that it has been a distinct benefit to the grower, the shipper, the warehouseman, and the transportation companies.

It has been determined that fruit is not likely to keep well if it is forced to growth. The apple handler has been told to watch the fruit more carefully and sell it relatively early in the season if it has been grown on rank-growing young trees. It has been demonstrated that the apple scald, one of the worst troubles with some varieties in cold storage, can be practically controlled by letting the fruit reach the stage of hard ripeness on the tree, by storing it quickly after picking in a temperature not above 32° F., and by selling relatively early in the season the varieties that are likely to scald. A large proportion of the losses from decay in the transportation and storage of fruit such as the apple and the orange is the result of breaking the skin, thereby making the fruit susceptible to the attacks of the common mold. Fruit is injured by rough handling to a far greater extent than the most experienced fruit growers and shippers have supposed. We have gone into the field and have shown how these injuries occur. Extensive shipping experiments have shown that the losses in injured fruit may be very heavy in transit and in storage, while perfect fruit of the same varieties may be transported or kept in storage in sound condition. It has been clearly proved that the delays that commonly occur in shipping and storing the fruit in warm weather cause the decays and the ripening processes to develop prematurely, and, in connection with improper handling, cause a large proportion of the storage and transportation losses.

The Bureau has demonstrated that the ripening processes and the

development of rots must be checked by cooling the fruit as soon as it is picked. Quick-ripening fruits, like "Bartlett" pears, do not cool quickly enough in the center of a barrel when placed in cold storage, and such fruits should be stored in small packages; fruit that is to be stored several months should be packed in closed packages to prevent it from shriveling; a wrapper lengthens the storage period, and a temperature as low as 32° F. keeps apples of all varieties, pears, peaches, and small fruits longer and in better condition than a higher temperature. It has been shown also that the losses from the ripening of fruit in the top of a refrigerator car may be reduced to an important extent by cooling it quickly, after picking, to a temperature of 35° to 40° F., and, further, that a refrigerator car, kept well iced, will maintain such a uniform temperature if the fruit is first reduced to that degree of cold. These investigations are having an important influence on improving the methods of conducting the fruit industry of the United States.

DRUG AND POISONOUS PLANT INVESTIGATIONS.

In the drug-plant investigations a field study of small areas of many kinds of drug-producing plants has been made in Vermont, in the District of Columbia, and in South Carolina, and it has been shown that many of the most important kinds will do well, e. g., poppy, belladonna, digitalis, wormwood, peppermint, etc. Curing processes have been studied and some of the most important features worked out. A method of utilizing the poppy plant or its parts as a crude source for morphine has been developed on a laboratory scale, and through the Office of Seed and Plant Introduction, a larger test of the commercial possibilities is planned. The production of camphor and licorice is being studied. Distillations from Florida camphor plantations have given a good yield of crude gum camphor. The production of camphor on a commercial scale will be tested in the near future. Certain important wild drug plants threatened with extermination have been successfully brought under cultivation. The utilization of weeds used in medicine has received some attention as a source of profit. American wormseed has been grown in South Carolina as a field crop with a profit comparing very favorably with that of corn, cotton, and tobacco. Yellow dock, burdock, stramonium, and other plants are also being studied. A laboratory and field study of the drug known as pinkroot has shown that this article has largely been crowded out by a spurious article.

The object of poisonous-plant investigations is to study the relation of stock losses to the eating of poisonous plants. Extensive field studies, especially in Montana and other Western States, have shown that great and often sudden losses are not infrequently due to the

eating of harmful plants growing on the range. The chronic trouble known as "loco disease" is now under study.

TEA-CULTURE INVESTIGATIONS.

In conducting experiments in the cultivation of tea in the South it has been demonstrated that the most important varieties of the tea plant, that from Ceylon excepted, make a growth and give a yield comparing very favorably with the results produced in their own lands. It has also been shown that negro children make expert tea pickers when properly trained. Several new and valuable machines have been invented: (1) A rotary sterilizing machine for withering the leaf to be made into green tea; (2) an attritionizer which at minimum cost polishes the tea, thus enhancing its appearance and market value. A new type of rolling machine is now being perfected to give a better "roll" to the tea than is given by the machines now in use.

Twenty-five acres of tea have been planted at Pierce, Tex., and a preliminary plucking indicates that a very high grade of tea will probably be produced. During the past season 9,000 pounds of tea were made at Summerville, S. C.

IMPROVEMENTS IN SEED DISTRIBUTION.

One of the most important tasks which the Department has to perform is the securing and distribution of the large quantity of seeds made necessary by the Congressional seed distribution. In the earlier work of the Department it was the practice to secure this seed, put it up, and send it out entirely with a departmental force. As the demand for seed increased and the work grew, it was found difficult to handle the complicated questions involved in this way. For a time the handling of the seed for the Congressional distribution was placed in the hands of contractors; but this was found unsatisfactory.

The Bureau of Plant Industry was charged with all matters pertaining to the seed work, and for the past four years has been giving special attention to improvements in the methods of securing, handling, and distributing. The Department has made a special effort to secure home-grown seed from growers and dealers in the United States.

A special effort has been made in the matter of encouraging bulb culture. While the actual number of miscellaneous vegetable seeds distributed has increased, the cost of the work has been diminished and the saving effected thereby has been devoted to the purchase, distribution, and encouragement of the use of improved seeds of various kinds. A special feature has been made of encouraging school garden work through the seed distribution. Formerly it was the practice to send the same kind of seeds to the cities as was sent

to the country districts. Now special arrangements have been made for placing in the hands of Senators and Members of Congress who have city constituents seeds especially designed for encouraging garden work in the public schools. Circulars of instruction have been prepared and issued with these seeds. Special attention has also been given to the securing and distribution of improved forage-crop seed, cotton seed, and other seeds.

FARM-MANAGEMENT WORK.

The Office of Farm Management has been developed in the Department during the past four years. Until recently its most important work has consisted in the study of farm practice. This study has resulted in finding many farmers who are preeminently successful in their chosen occupation. A careful study of their methods has been made. It has been completely demonstrated that preeminent success in farming consists in combining scientific knowledge with business methods. The publication of the results of these studies has aroused among farmers great interest in agricultural science. Some farmers who are following closely the teachings of agricultural science have been found who regularly secure a net income greater than the price of good farm land in this country.

As a result of the study of farm practice and of scientific investigation, it has been possible to establish object-lesson farms in various parts of the country, and 35 such farms are now in operation. The results obtained on these farms have surpassed expectations. On one dairy farm in the South the net income was doubled in one year. In another instance, a cotton farm with a net profit of \$5 per acre was converted into a hay and stock farm with net profits three times the value of the land when work upon it was begun by the Department.

The types of farming prevailing in various sections of the country have been studied, and the cropping systems best adapted to most sections have been determined. Methods of managing farms of different types in different sections have been devised.

Recognition of this work on the part of farmers has been such that the calls for information along these practical lines far exceed the facilities for meeting these calls.

FOREST SERVICE.

During the past year the Government work in forestry entered upon a new phase. Practical work in the actual introduction of forestry began in 1898, but it was not until February 1, 1905, when the care of the National forest reserves was transferred to the Department of Agriculture, that the Forest Service became an administrative organization.

This transfer was a logical outcome of the recent work of the Service. During the last six or seven years it has passed through a remarkable development, which has followed but not kept pace with its demonstration of capacity for public usefulness. On July 1, 1898, the Division of Forestry employed eleven persons, of whom six filled clerical or other subordinate positions, and five belonged to the scientific staff. Of the latter, two were professional foresters. The Division possessed no field equipment; practically all of its work was office work.

At the opening of the present fiscal year the employees of the Forest Service numbered 821, of whom 153 were professional trained foresters. Field work was going on in 27 States and Territories, from the Atlantic to the Pacific and from Canada to Mexico. Over 900,000 acres of private forest were under management recommended by the Service, and applications on file for advice from owners contemplating management covered 2,000,000 acres more. During the year nearly 62,000 letters were sent out from the offices at Washington, the majority of them in reply to requests for information and advice from the public, of a kind which could not be met by printed information.

This contrast imperfectly indicates the full extent of the change which has taken place, and the progress which has been made. Seven years ago there were in the whole United States less than ten professional foresters. Neither a science nor a literature of American forestry was in existence, nor could an education in the subject be obtained in this country. Systematic forestry was in operation on the estate of a single owner, honorably desirous of furnishing an object lesson in an unknown field. Lumbermen and forest owners were skeptical of the success of forest management, and largely hostile to its introduction. Among the public at large a feeling in favor of forest preservation, largely on sentimental grounds, was fairly widespread, but almost wholly misinformed. It confounded use with destruction, shade-tree planting with forestry.

The real need of forestry was urgent. A time had come which presented at once a great opportunity and a dangerous crisis. Forest destruction had reached a point where sagacious men—most of all, sagacious lumbermen—could plainly discern the not distant end. The lumber industry, vital to the nation at large, was rushing to its own extinction, yet with no avenue of escape apparent until forest management for future crops should be forced by famine prices. Meanwhile, however, the ruin would have been wrought already.

Timber-land owners were selling their holdings or their stumpage with little evidence of an understanding of their future value, and lumbermen were compelled by business competition to keep down

the cost of operation to the lowest terms or market their product at a loss.

Forestry was both an evident economic need and an apparent economic impossibility. Few well-informed persons believed that the obstacles to its introduction could be overcome sufficiently to bring it into common practice among private owners during the lives of the present generation.

That the whole situation is profoundly altered is directly and chiefly due to the work of the Forest Service. With its offer of practical assistance to forest owners made in the fall of 1898, its field of action shifted from the desk to the woods. The lumberman was met on his own ground. Uncertain speculations were converted into business propositions and untried theories into practical rules. Actual management for purely commercial ends has been taken up and applied on their own holdings by some of the best known lumbermen in the country. What lumbermen as a body now think of forestry is illustrated by the recent effective movement in their National association to endow a chair of lumbering at one of the forest schools.

Public opinion generally has experienced an equal change, and a sound National sentiment has been created. The great and varied interests dependent upon the forest have been awakened to the urgent need of making provision for the future. States have been led to enact wise laws and enter upon a well-considered forest policy.

Forestry is a matter of immediate interest to every household in the land. Forest destruction is no imaginary danger of a distant future. If it is not speedily checked its effects will sooner or later be felt in every industry and every home. To make these facts known is a National duty. The work of education must continue until public opinion will not tolerate heedless waste or injudicious laws.

PRESENT STANDING OF FORESTRY.

The period which has passed since 1898 has been, in forest work, a period of large definite accomplishments and of effective preparation for the future. Of the exact knowledge concerning our American forests, upon which the practice of scientific forestry depends, vastly more has been gathered during the last seven years than previously from the time Columbus landed. In 1898 the Division of Forestry had hardly approached the specific problems of forest management in the United States, and had developed no efficient methods of attacking them. The records now on file are based on the measurements of millions of individual trees. Commercial tree studies looking toward management have been prosecuted for 32 important species. Working plans have been prepared in 28 States,

and field work has been conducted in every State and Territory in the United States, and in Porto Rico, Alaska, and the Philippines.

The scientific knowledge gathered in the field has taken form in a rapidly growing literature of the subject, and has furnished the basis for a system of professional education. To-day there is scarcely more occasion for the American to go abroad to study forestry than to study medicine or law.

Besides creating a science of American forestry, the Forest Service has worked out the methods of operation by which forestry may be put in practice. It found in existence a fully developed system of lumbering, which had brought efficiency and economy of labor to the highest point, but was often wasteful of material and regarded forests as simply so much standing timber to be cut. Men taught to regard cheap logs at the mill as the supreme test and sole end of good lumbering, justly proud of their proficiency in a highly specialized industry, and impatient of restraint, could not be expected to welcome with cordiality changes for a purpose whose utility they were necessarily slow to recognize. To work a reform it was necessary to begin with existing conditions and improve them instead of criticising them. Had not the Forest Service taken the lead in finding out just how practical rules for conservative lumbering might be laid down and carried out, forestry could not have reached the point at which it now stands in the United States.

In the field of economic tree planting the same story is repeated and shows definite, important, and permanent results. It is true that in 1898 farmers throughout the Middle West, where tree planting finds its largest field of economic usefulness, were already alive to their need of planted timber. But the knowledge of what kinds of trees to plant and how to make them grow was imperfect. These were the fundamental problems: (1) The comparative adaptability of various species to regional and local conditions of climate, soil, and moisture; (2) the comparative usefulness of the species which can be made to thrive; (3) the protective benefits of planted timber; and, (4) the rate of growth and the future yield which can be expected.

Substantial progress toward the solution of all of these problems has been accomplished. The Forest Service has made in all 300 separate planting plans for private owners, covering an aggregate area of over 50,000 acres, in 36 States and Territories. It has completed regional studies of the broad conditions in the New England States, California, Kansas, Nebraska, Iowa, eastern South Dakota, western Minnesota, Illinois, Oklahoma, and the Ohio Basin in Ohio, Pennsylvania, and West Virginia. These studies largely supersede the necessity of future individual studies on the ground. It is now in a position to exercise great helpfulness in the whole planting

movement throughout the United States. It has established in the minds of western farmers generally the fact that tree planting can be made successful and that it adds to the money value of their farms. It has also called attention to the great hygienic importance of tree planting on the watersheds; of public water supplies of cities, east and west; has developed practical methods for reforesting denuded mountain slopes and for establishing new forest growth in regions of little rainfall, and has powerfully contributed to the great work of reclaiming desert lands through water conservation and to the whole irrigation movement.

THE GAIN IN ECONOMY OF USE.

The Forest Service has in the last seven years added greatly to our visible forest resources. In the saving of waste it has enriched the country by many millions of dollars, and in this way alone has added vastly more to the National wealth than its total expenditures for all purposes during its entire history.

Its most important achievements in decreasing the drain upon our forests by providing for their more effective utilization have been along four lines—determination of the strength of different kinds of timber, studies of methods by which timber may be made more durable, efforts to decrease waste in lumbering, and the discovery and introduction of better methods of gathering forest products other than lumber.

By its timber tests the Forest Service has established the suitability of various little-used but abundant woods, especially for structural uses, and has made possible the more economical use of other woods by an exact determination of their strength. By its studies of the effects of seasoning and the value of different methods of preservative treatment, it has opened the way to an enormous reduction in the drain upon our forests for railroad ties. What this demand at present is may be realized when it is considered that if a tree were growing at each end of every railroad tie laid in the track in the whole United States all the timber produced would be needed for renewal alone. In other words, two trees must always be growing in the forest to keep one tie permanently in the track.

By its studies of lumbering methods the Forest Service has shown lumbermen how timber formerly wasted in high stumps, tops, and logs left in the woods could be utilized without added expense. And a not less serious waste of a great resource was cut off when the invention of a new method of turpentining made it possible to eliminate the destruction of our southern forests through boxing the trees, and at the same time to gather a far larger value in turpentine than before.

FOREST EXPLORATION.

Finally, the Forest Service has rendered a great service by its explorations of forested regions. Useful contributions to the knowledge of our forest resources have been made through specific studies of important regions. Such studies have been completed for New Hampshire, Texas, California, the southern Appalachians, and are under way for every important timber region of the country. In addition the organized collection of the facts of production for the entire country has lately been begun. In the West, examinations by the Service have been of great value in selecting forest reserves and locating their boundaries. The guiding principle of this policy is, of course, that all land should be put to its best use. This principle the Forest Service has assisted to put into effect by its recommendations as to what lands should not as well as what should be reserved.

RESERVE ADMINISTRATION BY THE FOREST SERVICE.

The Forest Service had become fully qualified, by its past work, for the responsibility laid upon it by the transfer of the reserves to its administrative charge. The immediate effect of the change was the opening of the reserves to much wider use than ever before. This is the natural consequence of intrusting the care of these great forests to the only branch of the Government which has the necessary technical knowledge. The inevitable consequence of a lack of such knowledge must be the restriction of right use or the practical certainty of misuse. Only under expert control can any property yield its best return to the owner, who in this case is the people of the United States.

Under the system of administration now in force everything affecting the reserves is determined or executed by men of expert knowledge, familiar with local conditions. This entire force has become a part of the classified civil service. Timber is cut only under the supervision of trained men in accordance with a plan carefully prepared to safeguard the permanent welfare of the forest; yet the sales of timber have many times increased since the Forest Service took charge. A far more complete control is exercised than formerly, yet the net cost to the Government of all the work of the Service will be less for the present year than that of the Bureau of Forestry alone before the transfer. A property worth in cash not less than \$250,000,000 is administered at a cost of less than one-third of 1 per cent of its value, while increase in that value of not less than 10 per cent per annum is taking place. As the use of the reserves increases the cost of administration must, of course, increase also, but receipts will certainly increase much more rapidly. The forest reserves are certain to become not only self-supporting but a source of large public revenue.

WORK OF THE YEAR.

The transfer of the National forest reserves to the care of the Department of Agriculture was effected on February 1, 1905. The administration of these vast forests fell quietly into its place in the Service, and has since been conducted with steadily advancing efficiency. Every office in the Forest Service is actively concerned in their management, working and planting plans are in preparation and have been prepared for various parts of them, and they are absorbing and will continue to absorb a greater and greater part of the work of the Forest Service.

FOREST MANAGEMENT.

PUBLIC LANDS.

On the public lands greater strides were made in the introduction of forest management than ever before. Wherever on the reserves timber is in present demand working plans are being prepared which will insure the best use of the forests. On the Chippewa Indian Reservation, in Minnesota, the complete success of the plan to secure the perpetuation of the forests is assured. In California, Colorado, Montana, South Dakota, and Wyoming studies of leading commercial trees have provided a basis for the intelligent management of the forests in which these trees hold an important place, including many of the reserve forests.

PRIVATE LANDS.

The movement to introduce forest management on private lands is spreading rapidly, especially in the Pacific Coast States and the Middle West. Nearly four-fifths of the applicants for cooperative assistance were small owners. The total area for which assistance was asked was nearly 1,500,000 acres. Examinations to determine the practicability of management were made of 22 large timber tracts in 15 States, and detailed working plans were made for 8 large and 81 small tracts, with a total area of almost 2,000,000 acres.

Cooperative working plans for private land have secured for the Forest Service, at very small cost, data of the most important character concerning the leading timber trees and timber regions of the country. The depletion of supply and the dependence of numerous industries upon our hard-wood forests make the need of a knowledge of how to perpetuate these forests urgent. In the southern Appalachian region and on hard-wood bottom lands of the South Atlantic and Gulf States the studies of previous years have been rounded out, and the Forest Service is now equipped to recommend with confidence practical methods of management for commercial ends.

FOREST EXTENSION.

Up to the present year the work in extension found altogether its largest field of usefulness in the preparation of planting plans for farm protection and local timber supply in the scantily timbered regions of the Middle West. It is certain that tree planting will always hold an important place in farm economy, but it is more and more becoming possible to supply the needed information for this work from the central office as a result of regional studies. The large projects involved in the establishing or replacing of forests on reserve lands now unforested, and in demonstrating to the consumers of timber that they must provide for their future needs, will probably for the next few years increasingly claim the attention of the Forest Service.

During the year a revision of the terms of cooperative assistance was made to induce wider acceptance by small owners. Up to the present time 380 planting plans have been made, of which 49 were made during the past year.

Reserve planting during the year included the establishment of nurseries in the Santa Barbara and Gila River reserves, broadcast sowing and field planting on the Black Hills Reserve, and field planting in the San Gabriel and Dismal River reserves, besides the extension of previously established nurseries. The experiment in broadcast sowing in the Black Hills is especially notable, because the results obtained now appear to be entirely favorable and because success has never before been gained under this method in this country. The significance of this fact lies in the enormous difference in the cost of reforesting by sowing seed on ground not previously prepared and of rearing and transplanting nursery stock for large areas.

Forest-replacement studies were prosecuted during the year in the Wichita, Prescott, Pikes Peak, Santa Barbara, San Gabriel, San Bernardino, San Jacinto, and Sierra reserves.

By the completion of the cooperative study conducted in the State of California valuable information was secured concerning the relation of chaparral to water conservation and forest renewal and concerning fire protection.

FOREST PRODUCTS.

Lines of cooperative work now completed have brought definite and important results in introducing preservative treatment as a means of increasing the durability of ties, and thereby decreasing the drain upon the forests. The results give good reason for the belief that tie preservation will shortly become practically universal.

The study of the preservation of telegraph and telephone poles promises further economies of the same kind.

In timber tests, studies of red gum, red fir, western hemlock, and loblolly and long-leaf pine have furnished facts which will lead to the wiser use of these species and of structural timber generally. Strength tests of woods for other purposes have been begun, and methods have been prepared for the more extensive prosecution of this very practical work; but the full utilization of the opportunity presented for public usefulness must wait until the necessary facilities are provided.

DENDROLOGY AND FOREST EXHIBITS.

Progress was made during the year in the general study of forest distribution, classification, and composition throughout the United States, especially through regional studies. Previous studies of basket willows and turpentining methods have been continued with further helpful results.

BUREAU OF CHEMISTRY.

During the period begun July 1, 1897, and ended June 30, 1905, the present Bureau of Chemistry has increased its activities, and by reason of its enlarged work was raised from a division to the rank of a bureau July 1, 1901. The work of the Bureau has been seriously retarded, both during the past eight years and prior thereto, by reason of the large number of employees who, having attained a reputation for efficiency and ability, have been induced by superior opportunities of advancement to resign from the Bureau and enter work for other institutions or corporations. Nineteen of the promising members of the Bureau, during these periods, have resigned to enter more lucrative employment in other positions.

CEREAL INVESTIGATIONS.

The chemical investigation of the cereal products of the United States has been one of the principal items of work, and several bulletins have been published embodying the results of the investigations. Starting from the mean composition of the principal cereals, the chemical studies of the products made therefrom have included flours, meals, breads of every description, breakfast foods, cakes, and biscuits. This class of products is not subject to as many adulterations as are other foods. No instance has yet been found of such an adulteration. It frequently happens, however, that cakes colored to a yellowish tint, presumably by the eggs employed in their making, contain, in fact, an artificial color.

The changes which take place in cereal products during the process of milling are fully discussed in the above publications, and the differences, for instance, between the wheat and flour and other products and the bread made therefrom are exhibited in analytical data covering every phase of the process.

PREPARED MEATS.

Important investigations, also, were made in the study of prepared meats. As a result of these investigations it was shown that the process of parboiling, or "shrinking," as it is technically called, is practiced to produce a marketable article, since meat must be cooked before it is canned. The process was shown to detract little from the muscle-forming elements of the meat. The only substances removed in any considerable quantity are fat, soluble ash, and meat bases. In addition to this work, a systematic examination of the canned goods sold in the American markets was undertaken, and a total of 513 samples of such products were examined. It is interesting to note in connection with this work that in addition to the above 39 samples of horse meat were obtained, designed, according to statements made, for export to foreign countries.

Investigations were made to enable the analyst to distinguish horse meat which might be added to other meats as, for example, sausage. Only one instance, however, was found where it was certain that horse meat had been used in such a mixture.

The investigation of canned meats has proved of particular advantage, both to the manufacturers and consumers. That meat can be preserved unharmed for a long time when thoroughly sterilized in cans has been fully established as the result of the investigations. It has further been shown that it is not necessary in preserving the meat in this condition to add any chemical preservative whatever. The meats thus prepared preserve their wholesome properties and nutritive value and do not lose appreciably in palatability when not kept for too long a time.

FOOD PRESERVATIVES.

Elaborate studies have been made of the character of preservatives used in food products and the best methods of detecting them. These investigations have proved most useful to all workers in this line in the United States and foreign countries.

The natural occurrence in food of some substances used as preservatives has also been made a subject of investigation, as well as the alleged formation of chemical preservatives by the process of sterilization. It has been shown that such a synthesis of chemical preservatives does not take place and that the observations which have led to the contrary assertion are unreliable.

An important investigation has also been made to determine the effect of preservatives and coloring matters, when added to foods, upon the health of the consumer. To this end a class of young men was secured to whom were fed foods containing these articles. In so far as the investigations have been completed, it has been found

without exception that the addition of the ordinary preservatives to foods is prejudicial to health. The same is true, also, of at least one of the coloring matters commonly employed, namely, sulphate of copper.

The results of these investigations show the need of protecting the public by legislation against the addition of such articles to foods, either by prohibiting their use altogether or by regulating the amount thereof and securing a statement of composition upon the label of each package. In general, it appears that there are wholly unobjectionable ways of preserving food products, which should be followed, namely, by desiccation, by sterilization, or by cold storage. All of these methods are efficacious, but it must be understood that each of them has its limits and that, inasmuch as nature provides every year a sufficient quantity of food for mankind, there seems to be no reasonable excuse for preserving any food product over more than one season.

FOOD STANDARDS.

Important investigations have been conducted by the Bureau of Chemistry looking to the establishment of standards of purity for foods. The results of these investigations have been laid before the food standards committee of the Association of Official Agricultural Chemists, a body authorized by law to advise the Secretary of Agriculture, which has been instrumental in forming the standards already published as well as those which are still under consideration.

The lack of uniformity in the food legislation in the various States is a source of great annoyance to manufacturers and dealers. The Bureau of Chemistry has cordially cooperated with the officials of the various States in their efforts to regulate the manufacture and sale of adulterated foods, drinks, and drugs. It is becoming more and more evident, however, that for the complete control of evils of this kind interstate regulation of commerce in such articles is necessary. For this reason the officials of the various States, as well as the food manufacturers and consumers, are almost a unit in demanding that Congress enact legislation looking to the control of interstate commerce in adulterated foods, drinks, and drugs. Such an act would tend to unify the State laws and bring them into harmony, to give greater effect to the food standards which have been proclaimed under the authority of Congress, and to control in the most efficient manner the evils of food adulteration.

THE INSPECTION OF FOODS INTENDED FOR EXPORT.

The Congress of the United States has authorized the Department of Agriculture, through the Bureau of Chemistry, to inspect all food products intended for export to countries whose laws require a physi-

cal or chemical inspection of foods. This privilege, however, is optional with the exporter. He is not compelled to secure such an inspection, but is authorized to do so if he so desires. Under this law a great many of the exporters of food products in this country have applied to the Department for inspection of their goods. They have thus been enabled to send with the foods to foreign countries a certificate of inspection, which as a rule is accepted as *prima facie* evidence of purity. It is evident that our foreign commerce in food products would be greatly promoted if this practice should become general, and our foods would thus acquire a standing in foreign countries which would remove from them all suspicion of impurity.

INSPECTION OF IMPORTED FOODS.

Congress has also authorized this Department to inspect all food products offered for entry into the United States from foreign countries and to refuse delivery to the consignee of all products which are found to contain any added substance injurious to health, or to be misbranded in any particular, either as to their contents or origin, and of such products as are forbidden or restricted in sale in the country from which they come or from which they are exported. In order to carry this law into effect, branch laboratories of the Bureau of Chemistry have been established in the ports of New York, Boston, Philadelphia, New Orleans, San Francisco, and Chicago.

As far as the facilities at hand will permit, all food products entering this country are inspected and analyzed before delivery to the consignee. As a result of this inspection a great improvement in the character of our imported foods has already been secured. There has been developed also among the exporters from foreign countries a desire to send only such articles as may conform to the requirements of the laws of the United States. The law has already been of great advantage to the American consumer, and when the facilities are provided to apply it to practically all imported food products, we may feel assured that in so far as the foreign articles are concerned at least the American consumer will be entirely protected. This is an additional reason, also, for desiring an act of Congress regulating interstate commerce, so that the wise provisions of the law of inspection may be applied also to foods of domestic origin passing from one State to another.

During the period between July 1, 1903, when the enforcement of the law began, and June 30, 1905, 3,576 invoices of food products were inspected, among which 712 were found to be of a character forbidden by law.

INFLUENCE OF ENVIRONMENT UPON COMPOSITION.

Interesting studies have been and are still being made by the Bureau of Chemistry regarding the influence of environment upon the chemical composition of plant products. The object of these investigations is to show just what factors of environment are most active in producing certain results. When this has once been determined, the enlightened farmer may take advantage of natural forces for the purpose of modifying this crop and making it better adapted to its intended purpose and, therefore, more valuable. One complete series of investigations of this kind has been concluded, namely, with the sugar beet; and it is shown from these investigations that the temperature of the growing season is the dominant factor in determining the sugar content of the beet. The lower the temperature the higher the sugar content. These investigations show the futility of attempting to grow sugar beets in southern regions, even where the soil and other climatic conditions are suitable to the production of crops of large size.

Similar investigations are being made concerning the character of wheat and other crops as affected by environment. These investigations, though strictly scientific, are certain to result in practical applications which will prove of the greatest benefit to agriculture.

TABLE SIRUPS.

Important investigations have been made in the last few years looking to the improvement of the character of the table sirups so largely used in the United States. These sirups are made chiefly from the maple tree, from sorghum, and from sugar cane. These investigations have shown the best methods of procedure in all these cases to secure a product of the highest quality, free from added chemicals. Several bulletins have been published embodying the results of these investigations.

INSECTICIDES.

An elaborate study has been made of the insecticides in use in the United States, in collaboration with the Bureau of Entomology. These investigations have shown that many of the insecticides offered to our farmers are of little value, and that the price demanded and the value of the goods are not always proportionate. These studies have tended to protect the farmers of the country and secure for them a much better quality of insecticide for the money expended.

CONTRACTS.

In the Contracts Laboratory studies are made of the materials submitted for the Department of Agriculture, and other Departments of the Government which may ask for such studies. The results of

these studies are of the greatest practical benefit in securing for the use of the United States Government materials which fully conform to the requirements of the contract and the character of the samples submitted. The extension of this inspection to all materials supplied the United States Government would undoubtedly prove advantageous.

LEATHER AND TANNING.

Investigations of both a scientific and practical nature were made in connection with the leather and tanning industries of the country. The leather trades have an invested capital of about \$356,000,000, and the economic relations of this industry to our forests and our cattle supply have been but little studied. Chemistry plays the most important part in these studies, since it determines not only the amount of tannin and the distribution thereof in tannin-producing materials, but also indicates the methods by which the processes of tanning are conducted. These studies, therefore, have direct practical bearing upon great industries of National importance.

DRUGS AND CHEMICALS.

The importance of pure drugs from the hygienic and remedial standpoint is evident to everyone. Congress has authorized the study by the Bureau of Chemistry of the purity of drugs, their nature, and the sophistications to which they are subject. The Drug Laboratory of the Bureau of Chemistry pursues investigations of this kind, as well as of the purity of chemicals and reagents offered for the use of the Bureau.

COOPERATIVE WORK WITH THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

The work of the Bureau of Chemistry in connection with the Association of Official Agricultural Chemists of the United States has been of a most useful character. This association is composed of all chemists connected with agricultural colleges, experiment stations, State and municipal boards of health, boards of agriculture, etc.; hence it represents some of the most important activities in connection with agriculture. By act of Congress this association is made the adviser in certain respects of the Department of Agriculture, and this Department has extended its patronage to the association from the beginning, with great mutual benefit, and still greater benefit to the agricultural interests of the country.

CIDER AND WINE INVESTIGATIONS.

It is well understood that the character of ciders, wines, etc., is due to the chemical reactions which take place during the process of fermentation. Special studies have been made by the Bureau of Chem-

istry of these chemical reactions, especially with relation to cider, and numerous cultures of yeast, producing specific properties, have been made and distributed.

Careful studies of the wines of this and other countries have also been made which have proved of great practical benefit.

MISCELLANEOUS CHEMICAL INVESTIGATIONS.

Some experiments have been made with apples and peaches to determine just what changes take place in cold storage. An analytical study of tropical fruits, especially those of Porto Rico, was also made.

Salad oils have been investigated, and the extent of the adulteration of olive oil with other edible oils has been ascertained.

Studies of vinegar have been made to ascertain the best methods of distinguishing between cider vinegar and others, such as wine vinegars, malt vinegars, etc.

An investigation has been made to determine the character of the cod-liver oil imported into the United States and the extent of its adulteration.

Studies have been made of the waters used or intended to be used for irrigating purposes. When the help of the Bureau has been asked for by the municipalities, water supplies have been studied to determine their sanitary character.

Sanitary studies have also been made of the distribution of arsenic in wares commonly found in domestic use, such as wall papers, fabrics, etc. A large number of such articles have been found to contain quantities inimical or prejudicial to health.

COLLABORATION WITH OTHER DEPARTMENTS.

Under the authority of Congress the Bureau of Chemistry is authorized to collaborate with other Departments which may require its aid. Under this authority work is constantly done for nearly all the Departments of the Government. A large number of investigations has been made for the Treasury Department; also for the War Department, especially for the Commissary-General; for the Interior Department; for the Navy Department; for the Department of Commerce and Labor, and for the Department of Justice.

During the last two or three years the most important of the collaborative work with the Departments is that which has been done in connection with the Post-Office Department. The Postmaster-General submits constantly to the Department of Agriculture for investigation samples of various substances which are intended either to be sent through the mails or advertised in newspapers, magazines, and circulars sent through the mails. Under the law poisonous matters

and those which are combustible in character or dangerous to other wares are not allowed to be sent through the mails. Samples of such suspicious bodies are constantly submitted for investigation.

There are continually appearing advertisements of remedies said to possess most remarkable characteristics and to effect marvelous cures. Where such advertisements appear to be fraudulent in character, they are submitted, together with samples of the remedies, to the Bureau of Chemistry. After careful examination of the samples and of the literature reports are made to the Postmaster-General, embodying the results of our investigations and the conclusions based upon them. On these investigations and conclusions the Post-Office Department bases its action in either continuing the use of the mails for the distribution of such advertisements or debarring them from the mails as fraudulent. Much benefit must necessarily come to the people of the country from work of this kind.

From the above review of some of the important investigations conducted in the Bureau of Chemistry it is seen that chemistry is a science which touches almost every question connected with scientific agriculture.

From the inception of the Department of Agriculture, by reason of the provision of the organic act establishing it, the services of the science of chemistry have been freely utilized to secure the development and prosperity of the agricultural industries of the country.

BUREAU OF SOILS.

The work of the Bureau of Soils is of such a fundamental character that its results are being more and more widely used, not only by the other Bureaus and Divisions of the Departmental work, but by State agricultural experiment stations and State geological and economic surveys, as a foundation for further work along highly specialized lines. At the same time that the demands upon the Bureau for additional work are increasing, the facilities for accomplishing this work have remained stationary or, in one case, been decreased.

During the past eighteen months the Soil Survey has lost by transfer to the United States Geological Survey, by assignment to alkali reclamation work within the Bureau of Soils, by the cooperation with other Departments of the United States Government and of the Philippine government, by special detail to educational institutions, and by resignations twenty of its most highly trained and efficient assistants. The Survey force, even with these depletions, mapped over 28,000 square miles during the calendar year 1904. With twenty parties of two men each continuously engaged in field mapping, about 35,000 square miles per annum could be surveyed and mapped.

The Bureau of Soils has on file at the present time requests for the mapping of two hundred and fifteen counties, located in forty States and Territories, and aggregating upward of 150,000 square miles. These requests are supported by 265 organizations and individuals.

Requests are on file either from the directors of experiment stations or from the State geological survey organizations for surveys of all of the areas of several States. The States thus covered include Kansas, Louisiana, Missouri, and North Dakota, and in addition the State organizations of Mississippi, New York, North Carolina, Oklahoma, and Tennessee request that work should be extended as rapidly as possible within their States in order to precede various forms of experimental work or additional survey work in which the State organizations desire to engage.

Requests and petitions from the State of Texas call for the survey of forty-two counties in that State. These requests are indorsed by both Senators from the State, by nearly every member of the Congressional delegation, by several commercial clubs, and by fruit-growers' and truck-growers' associations. Nearly every other State in the Union has furnished similar requests.

The Soil Survey at the present time is equipped with a force of 29 field men and some of the necessary executive and special assistants. In order that the work of this survey may be kept at its former efficiency, in view of the recent depletions, it becomes necessary to increase the number of field men engaged upon actual survey work to 40 persons, thus allowing the maintenance of 20 parties upon continuous field work. On account of the necessity of providing for resignations, for annual leave of absence, and for necessary sick leave, additional men are needed to keep these field parties constantly at their full efficiency. For this maintenance of the field force at least 12 more men are required for the Soil Survey service. To keep in close touch with all of the work as it is being conducted in the field and in order that the necessary correlations of the soils of one area with those of other areas which are in progress of mapping or have already been mapped may be made, it is necessary to have two inspectors, both highly trained men, appointed from the present Survey force, who will visit each area during the progress of the work and advise the men in regard to all difficulties which can not be solved through correspondence. Through their personal contact with the men the inspectors will keep the field work up to the highest state of efficiency and economy. The places on the Survey thus made vacant would need to be filled by the appointment of two new men at smaller salaries.

The men required to supply these additional places can only be obtained from a limited number of sources in the United States at the present time. While several of the agricultural colleges are

training men along various lines of soil investigations, only a few of these colleges are equipped with men who can train students in the actual practice and conduct of soil-survey work. As a result the Soil Survey has to depend largely upon men whose training is of a general rather than a special character, and these men must receive additional training before they can be placed in charge of the important work of soil mapping and soil classification.

The character of the work already accomplished and the broad scope of the problems encountered in the areas already surveyed are shown by a recapitulation of the work of the Soil Survey from its inception to June 30, 1905. All of the problems encountered in the field require additional research work in the laboratory for their complete solution. This is particularly true of the two great problems of American agriculture which concern, respectively, the arid lands and the humid lands of the United States. The first study concerns the accumulation of soluble salts, known as alkali; the second problem is that of soil fertility, or, as it is sometimes stated, that of "worn-out soils." Both of these problems are being studied by the laboratory force, and the results obtained are published in the form of special bulletins, which summarize the scientific facts discovered, and also in the form of circulars or additions to the Soil Survey reports, in order that the results may be placed in such a form as to constitute a practical working basis for the persons whose farms are concerned. In the same way the Tobacco Investigation work follows and supplements the Soil Survey. Recently arrangements have been made whereby cooperation has been secured with certain agricultural experiment stations and with the Office of Farm Management of the Department of Agriculture. Through this arrangement it is hoped to come into very close touch with all branches of American agricultural activity.

EARLY WORK OF THE SOIL SURVEY.

The first work of the Soil Survey consisted of preliminary studies of the tobacco soils of the United States and of the alkali soils of the Yellowstone Valley. These investigations showed that a field map could be constructed which would represent graphically the classification, occurrence, and distribution of distinctive types of soils. It was also found that in the arid regions of the West a second map should be constructed which would show the amount and character of the alkali, which frequently interferes with crop production or totally prohibits it. It was also found in the case of the arid regions that a map showing the depth to permanently saturated soil was necessary. For this reason, in the conduct of soil surveys in the arid regions, a soil map, an alkali map, and a ground-water map are prepared, whereas in the humid regions the soil map alone is sufficient.

Each of these survey maps is accompanied by a report upon the climatic surroundings of the region, its transportation and market facilities, and the special adaptation of different crops to the different soil types, together with an outline of the transportation problems and of such other commercial, economic, and other essential facts as directly influence agricultural welfare and agricultural life.

THE VALUE OF THE SOIL.

The soils of the United States are considered as the greatest natural economic endowment of the American people, far exceeding in the value of their annual products all of the returns secured from mines and fisheries. It is the purpose of the Soil Survey work to outline the most economical method of securing the utmost efficiency in the handling of these soils and in the production of food products from them. The questions involved concern not only the farmers themselves, but also every person interested in labor, commerce, manufacturing, or professional life. The problems are fundamental.

The studies thus far made of the soils of the United States include the survey of 197 separate areas, located in 44 States and Territories. These surveys aggregate 63,621,120 acres, or 99,408 square miles. They have been so distributed as to constitute a study of soil conditions in all the different physical divisions of the United States and for all of the chief staple crops. In addition, the special conditions favoring the production of special crops under intensive methods of agriculture have also been studied.

Surveys of the tobacco soils of the United States have been made in 16 different States. Their results show that the variety of leaf produced is controlled largely by the texture of the soil upon which the crop is raised. Thus, the heavy clay soils produce a thick, gummy leaf, while the lighter sands produce wrapper leaf and bright tobacco.

The soils of the truck-producing regions along the Atlantic and Gulf coasts have been studied from Rhode Island to Texas. It has been found that the Norfolk sand is the best soil for the production of early truck crops in all of the tide-water districts of the eastern coast line. Where market facilities and transportation are favorable the land values upon the Norfolk sand have risen from \$5 or \$10 per acre under general farming conditions to \$100 or \$200 per acre for the production of sweet potatoes, early Irish potatoes, melons, small fruits, and small vegetables. The interior truck regions of the Central States have been similarly studied, and in this region the Miami sand has been found to be the type of soil best adapted to truck farming.

The grape soils of the United States have been studied in the Lake Erie region and in California. It has been found that the sandy and

gravelly soils adapted to the production of the eastern wine and grape-juice grapes do not furnish a product well suited for shipping, and the production of table grapes for distant markets is best accomplished upon the heavy clay and shale-loam soils of what is known as the Dunkirk series. In the California grape belt of the San Joaquin Valley the alkali problem was found to be serious. The soil-survey work around Fresno has been followed by alkali reclamation work. It has been shown that with an expenditure of less than \$40 per acre soils which have decreased to the value of \$20 or \$30 per acre for grass and grain production can be restored to their former value of \$350 to \$700 per acre for grape production.

STUDY OF APPLE SOILS.

The apple industry has been served in two notable instances. The soil survey of the Lyons area in Wayne County, N. Y., was followed by an orchard survey made under the direction of the horticultural department of Cornell University. Thus, a map showing the adaptation of apples to the various soils has been supplemented by a comprehensive bulletin which discusses the question of the varieties to be raised for commercial marketing, the methods of culture and the fertilizer to be employed, questions of storage and shipment, and even the facilities offered by the different domestic and foreign markets. In the same way the great pippin belt of Maryland, Virginia, and North Carolina has been studied. It was found that the profitable production of pippins was confined to a single soil type—the Porters black loam—occurring in the coves and small valleys of the eastern ranges of the Allegheny Mountains. It was also found that not only were the most successful orchards located upon this soil type, but also that a distinct climatic belt also existed within which the pippin production was especially favored. On account of differences in latitude this belt descends from higher elevations in the South to lower elevations northward. In Virginia it occurs between altitudes of 1,200 and 3,000 feet.

SOILS ADAPTED TO CITRUS FRUITS.

On the Pacific coast extensive studies have been made of the soils adapted to citrus fruits. Here it has been found that not only the soil played an important part in the location of groves of citrus fruits, but that the alkali problem and the conservation of irrigation water constituted dominating factors. The use of irrigation water containing considerable amounts of soluble salts for the safe irrigation of citrus and pomaceous fruits has been studied in this district. The melon-producing areas around Rockyford, Colo., and Indio, Cal., have been studied and the soils best adapted to the production of high-grade

cantaloupes determined. It is found that the fine sandy loams of both regions, under proper irrigation conditions, constitute the best melon soils.

SUGAR-BEET SOILS.

In conjunction with the extension of the sugar-beet industry into eastern areas, it has been found necessary to take up the study not only of eastern sugar-beet soils, but the study of the soils upon which sugar beets have long been produced to advantage in the irrigated districts. It has been found that the soils best adapted to raising sugar beets in the arid regions are not at all the soils adapted to sugar-beet production under humid conditions. In the former the sandy loams and adobe soils constitute the main sugar-beet producing types. In Wisconsin, Michigan, northern Ohio, and central New York the heavier loams or clay loams well supplied with moisture and still not too stiff to interfere with root development constitute the best soils for this crop. In Michigan and northern Ohio these soils are the Clyde loam, Clyde sandy loam, and Miami black clay loam. All of these are dark in color and contain considerable quantities of partially decayed organic matter. In New York the Miami stony loam and Miami silt loam are the soils upon which the best results are obtained.

ALFALFA SOILS.

The introduction of alfalfa into the Eastern States and its production under humid conditions have necessitated a study of alfalfa soils from New York to Alabama and Texas, and also throughout the central prairie region. While the soil factor is not the only one controlling the introduction of this crop, it has been shown that when other conditions are reasonably favorable the Miami stony loam of the Northeastern States almost invariably gives the best results for alfalfa growing. Similarly, in the Gulf Coast States, when proper drainage can be secured, the Houston black clay or the black "waxy land" of the Cretaceous prairies, as it is locally known, constitutes a soil type upon which alfalfa grows almost spontaneously.

RICE AND SUGAR CANE SOILS.

The rapid development of the rice industry in Louisiana and Texas within the last decade has necessitated a study of the soils of that general region. It has been shown that under the modern conditions of production, with the use of heavy power machinery and under copious irrigation, the heavier silt loams and clay loams of the low-lying Louisiana and Texas prairies are best adapted to this modern industry. The Crowley silt loam, Lake Charles fine sandy loam, and other similar types are the ones upon which this crop is meeting with the greatest success.

The sugar-cane interests have been served by a number of surveys along the Gulf coast. One area of special interest was mapped around the sugar station of the Louisiana Experiment Station. The results obtained upon the soils mapped in this area can readily be applied in connection with the same soil types mapped in the other Gulf coast areas.

While the Soil Survey is thus serving numerous special interests and in a great many instances obtaining new results which are striking and gratifying, the total value of these is possibly small compared with that which comes from a study of the soils which produce our great staple crops like grass, wheat, corn, oats, and cotton.

IDEAL CORN SOILS.

The study of soil conditions in the great central cereal belt of the United States has demonstrated that three types—the Marshall silt loam, Marshall loam, and the Miami black clay loam—are beyond dispute the ideal corn soils of the central prairie States. The study of the extent and distribution of these three types, whose products dominate one great branch of American agriculture, has led to a better understanding of the conditions which lead to successful corn production. As the studies of corn breeders have led to new inspiration in the plant side of corn production, so the delimitation of these types of soil so admirably adapted to the production of maize will furnish direction for increased specialization in the selection of the best possible soil conditions for corn production.

At the same time it has been shown by the soil surveys that the typical corn soils of the central prairie States are not at all the most desirable corn soils for the northeastern and eastern tide-water States. Owing to greater elevation and a consequent shorter season the corn crop can be matured only upon those soils which are at once well drained, well warmed, and sufficiently retentive of moisture to satisfy the demands of a heavy, rank-growing crop. So in New York and the northeastern States in general the gravelly and stony loams lying below an altitude of 1,500 feet constitute the corn soils.

Again, in the Piedmont and Coastal Plain regions of the southern seaboard States it has been found that another entirely different set of conditions must be met. Corn does not thrive below an altitude of 100 feet, just as it is not successfully cultivated above 1,500 feet. Again, certain climatic peculiarities intervene to alter conditions of production. As a result the heavy loams and clays of the Cecil and Penn series and the heavier loams of the Orangeburg and Norfolk series constitute the soils best adapted to corn culture in these regions.

In addition to these uplands suited to corn production in the Southern States the narrow alluvial bottom lands, frequently subject

to overflow, are found to constitute by all means the best corn soils of the region, and only their limited extent and the difficulty of protecting them from destructive inundation prevent these soils from being recognized as among the most desirable of any in the United States for corn production. The problem of the proper protection of these bottom lands, either by watershed forestation or by local levees, constitutes one of the most important problems of local production of provision crops throughout the South.

SOILS ADAPTED TO SPECIAL CROPS.

Several soils of the Northeastern States upon which an unsuccessful attempt is being made at the present time to produce cereal crops actually constitute the best grass lands of the region. This is particularly the case of the Volusia silt loam of northeastern Ohio, northern Pennsylvania, and southern New York. This soil lies at an altitude of 1,300 to 2,000 feet above sea level, and the production of corn is an uncertainty on account of the occurrence of unseasonable frosts. As a result, the farming population of this general district, particularly in the hill lands, is becoming discouraged and disheartened, while the soil with which they are dealing is admirably adapted to the production of grasses, oats, and buckwheat. The abandonment of grain farming and the turning to dairy industry and stock raising, based upon hay and oat production, would seem to be highly desirable throughout this general region.

STUDY OF COTTON SOILS.

A constant study is being made of the cotton soils of the Southern States. These communities have shown wonderful progress both in agriculture and manufacturing during the past decade. The study of soils in the Yazoo and Red River basins of Mississippi and Louisiana has shown ideal soil and climatic conditions for the continued production of maximum cotton crops. The annual overflows naturally enrich the plantations and render the soils subject to this influence of almost inexhaustible fertility. It was pointed out in the Yazoo report that the chief problem of these regions was to secure adequate protection from destructive inundation, while still securing the fertilizing benefits of the overflow waters.

Similarly the Upland cotton regions have been found to present two dominant soil problems. The first is that of preventing the bodily removal of the fertile surface soil through erosion; the second is that of securing such a rotation of crops and use of green manures as will restore the organic matter to soils depleted by long-continued clean cultivation in one crop. Both of these problems can be met and are being met by enterprising farmers in nearly every community where soil surveys have been made. The mere statement of these

problems and the accounts given of cases where their solution has been worked out are of inestimable value to the planters whose attention has not formerly been called to the work already done by their own neighbors and by their local authorities.

ARID AND SEMIARID REGIONS.

The introduction of durum wheat into the regions sometimes deficient in rainfall, but not naturally arid, requires a careful investigation of the soils to which this new crop is best adapted. So soon as the proper soil conditions can be ascertained there is a good prospect that a vast region marked formerly by uncertain harvests can become dependent on a totally new industry adapted to its peculiarities of soils and climate.

The interests of agricultural areas as yet undeveloped have also been served. The new irrigation areas of the arid States are being investigated and maps made which show not only the kinds of soils which exist and their proper crop adaptation, but also the locations of land too alkaline to be of any present value for crop production.

PRACTICAL UTILIZATION OF THE SOIL SURVEYS.

Survey of single areas of this description have furnished prospective settlers with information which has prevented the unwise investment or total loss of thousands of dollars, in many instances constituting every dollar possessed by the individual. At the same time these settlers have been directed to lands within the same areas where their investments could be made with safety and their new homes established without risk of disappointment. The actual settler has thus been benefited, and new communities have secured advance information which only years of bitter experience would have furnished them under their own undirected efforts.

It will thus be seen that the Soil Survey reports and maps concern not only those engaged in the broad study of economic agriculture and its resources in the United States, but that they are of high value for daily use by a great variety of agricultural and commercial interests. The increase of the use thus made of the maps and reports is evidenced both by the requests received for reports already published and by the requests which are continually being made for additional surveys. It is possible only to enumerate the interests which make these requests. These include canning companies, granges, farmers' clubs, and other agricultural organizations; the leading educational institutions, not only those practically interested in agriculture, but also those which study agriculture as a portion of the economic system of the United States; the geological departments of the leading universities, and botanical, geological, agricultural, forestry, and

irrigation surveys. The use of these maps by individual farmers, and particularly home seekers and those desiring to engage in special intensive forms of agriculture, is rapidly increasing. This is shown by the fact that maps of areas which are being developed along new lines of fruit growing, trucking, or market gardening are in great demand by individuals. Thus, Long Island, N. Y., Wayne County, N. Y., Norfolk, Va., and other areas mapped in the older settled States have met with the largest demand for single copies of the report and map of any of the areas published during the last two years.

MAINTENANCE AND RESTORATION OF SOIL FERTILITY.

The study of the main agricultural question of the humid sections—that of maintaining soil fertility, or of restoring lands to their former crop-producing power—has been taken up. It has been found through centuries of experience that there are three chief methods for maintaining the fertility of soils. The first of these—manuring or fertilization—is most generally practiced in the United States; the second method—crop rotation—is also widely practiced, and its importance is becoming thoroughly understood; the third method—that of proper culture or tillage, which would include drainage and irrigation—is of more modern origin, so far as the American people are concerned, and is less thoroughly understood and less widely practiced. A study of the relative values of each of these methods and of the relationship of each to the other must be made in order to meet the requirements of recent growths of agriculture in the United States. The broad areas of virgin soil which formerly existed in the United States invited the most superficial cultivation. Crop rotation was neglected or carried on in a haphazard fashion. Under mismanagement and unwise methods, engendered by long periods of abundant cheap land, the time must sooner or later arrive when the soils do not respond to cultivation with profitable crops. Recourse is then had to some form of fertilizer. This point has already been reached in certain portions of the United States.

NEW METHODS FOR TESTING FERTILIZER REQUIREMENTS.

In order that the restoration of these lands through the application of different manurial and fertilizer compounds may be accomplished most economically, the problems of soil fertility and of soil management have been taken up by the Bureau of Soils. New methods have been devised for testing the fertilizer requirements on each of the principal soil types encountered by the Soil Survey. This method gives results in about six weeks' time which have been found to be practically comparable with the results of plot experiments carried

on over longer periods. The new method has been tested against the fertilizer and manurial plots of two leading experiment stations, one in Rhode Island and one in Ohio. The results of these tests have been highly satisfactory, not only to the Bureau of Soils, but also to the directors of the two stations. Letters from them are on file which show their appreciation of this new line of work. In order that the method may be completely tested, work has been arranged for the ensuing year in cooperation with four additional stations.

The parties assigned to this work will study not only the manurial requirements of soils occurring at the stations, but they will also study the fundamental questions of the principles involved in the maintenance of soil fertility. In addition to this use of the new methods devised in the Bureau laboratories, work is being carried on for the determination of the manurial requirements of each of the principal soil types of the United States as they are encountered in the different areas which are being surveyed. The soils from thirty-nine different localities have already been investigated and a circular giving the results of these investigations has been published in three of these cases. It will thus be possible in connection with each survey to include directions for the fertilization of each of the different soil types encountered, with the reports upon the areas as they are published. It is only natural that investigations into such fundamental problems as those concerning soil fertility and manurial requirements should attract general attention and bring numerous comments from other investigators along the same lines. This has been more pronounced in the fertility studies, because not only the results obtained, but also the viewpoint and even the methods employed, were essentially new. It has been found necessary, in addition to the publication of the usual bulletins and circulars, to meet many of these inquiries by lectures upon the principles of the work and by exposition of its method of operation before the faculties and students of several scientific institutions. As these methods are becoming more thoroughly understood they are being gradually adapted for scientific work along the same lines by investigators who are working outside of the Department of Agriculture.

RECLAMATION OF ALKALI LANDS.

Another of the important problems of American agriculture—that of the control of alkali—chiefly concerns the arid regions of the United States. As a result of the very first survey work in such areas, it became manifest that certain methods should be employed to prevent the accumulation of alkali in irrigated lands and to reclaim those lands which had already been damaged by accumulations of soluble salts. This situation was met in earlier reports by recommendations concerning proper methods to be employed, but it was

found that in order to bring this matter convincingly before the people most concerned and to get them to follow the recommendations made, it would be necessary to conduct actual demonstrations; consequently in 1902 the work of the Alkali Reclamation Service was begun upon the Swan tract, near Salt Lake City, Utah. This tract has been thoroughly underdrained, and frequent applications of irrigation water have been made by the method of flooding. After three years this land, which at the inception of the demonstration produced only greasewood and saltbushes, has produced fair crops of wheat and alfalfa. At the expiration of another year this tract should be completely reclaimed, and in addition should produce good yields of farm crops adapted to the soil and climate.

Similar demonstrations have been undertaken in Montana, Washington, California, and at an additional station in Utah. These demonstrations will be completed in about the same time required for the original Swan tract. This reclamation of alkali land by thorough underdrainage, on account of the expense involved, is adapted only to the reclamation of lands of relatively high value.

TEXAS TOBACCO SOILS.

In Texas the possibilities of certain soils of the Orangeburg series for the production of high-grade filler tobacco have been investigated by field parties with headquarters at Palestine, Anderson County, and with substations in Nacogdoches County and Houston County. Experimental fields aggregating 103 acres have been planted in cooperation with thirty-four different farmers. The entire production of the Texas fields has already been bought by a Chicago firm at a very satisfactory price, and it was bought before the crop was even fermented. It is thus evident that a ready market for the Texas product can be secured.

The people of this general region are totally unskilled in the technical details of the production, curing, and marketing of tobacco. At the same time, the invasion of the boll weevil has rendered the introduction of some crop in addition to cotton highly essential to the welfare of this agricultural community. It is therefore necessary for the Department to maintain these tobacco stations in this region long enough to encourage and advise the individual farmers in firmly establishing this new line of crop production. A great interest is taken in this tobacco work by individuals and business organizations in eastern Texas. The same line of work has been taken up in Alabama, around Marion, with the same general results.

TOBACCO WORK IN OHIO.

In Ohio the Bureau has practically finished its experimental work. The crop grown upon 32 acres in cooperation with eight different farmers in Montgomery County was purchased at very

remunerative prices even before it was cut. The work of tobacco fermentation in cooperation with the Ohio tobacco men has been continued. This is the fourth season for this line of work, and practically all of the Ohio packers have now abandoned the old practice of case fermentation, substituting the Bureau method of bulk fermentation. This change has resulted not only in the saving of thousands of dollars formerly lost through imperfect curing and through black rot, but it has also added materially to the profits of all tobacco by a general improvement in the quality of the different crops.

TOBACCO WORK IN VIRGINIA.

Work has been extended in the dark-tobacco districts of Virginia, where tobacco growers were securing very unsatisfactory returns for their labor. A station was established in Adams County and a number of experimental plots established upon the Cecil clay. Different methods of fertilization and of handling were tested. The result of a single season's work indicates that the methods introduced by the Bureau of Soils will result in profits on the investment of fertilizer and labor of from 13 to 35½ per cent. These conclusions are drawn from the results of actual field experience. Although only one year's work is concerned it has been clearly shown that by a judicious use of fertilizers and with thorough and proper cultivation it will be possible for the Virginia tobacco raiser to increase his yield and his profits materially.

SHADE-GROWN TOBACCO IN CONNECTICUT.

The work in the Connecticut Valley upon shade-grown wrapper leaf has been continued. The object of this work is to develop a type of tobacco which at the same time is adapted to the soil and climatic conditions of Connecticut and to the market demands. During the year nearly 100 bales of this tobacco have been sold for domestic use. The prices obtained range from 20 cents per pound to \$1.75 per pound, with an average of 75½ cents. Eighty-six bales unsuited to the domestic demands were sold for export at prices ranging from 10 to 70 cents per pound, with an average price of 27.8 cents per pound. The Bureau has again demonstrated the possibility of growing a superior class of wrapper tobacco under tent shading in the Connecticut Valley with a substantial margin of profit.

MISCELLANEOUS TOBACCO WORK.

The tobacco work of the Bureau of Soils includes the improvement of domestic filler tobacco through the introduction of the Cuban seed-leaf industry into the Southern States and into Ohio; the

introduction and supervision of the bulk fermentation process in Ohio; the completion of the experiment for producing a shade-grown wrapper tobacco in Connecticut which will meet trade requirements; the work of improving the filler types of shipping tobacco in Virginia; and it is very desirable that investigations of the same kind should be made in the tobacco districts of New York, Pennsylvania, Maryland, Wisconsin, Kentucky, and Tennessee.

Requests for this work have been received from many farmers, from various tobacco growers' associations, and from a variety of trade interests. The importance of this work is obvious, and the Bureau is prepared to carry on and enlarge this line of work in the future as rapidly as appropriations can be made available.

BUREAU OF ENTOMOLOGY.

The work of the Bureau of Entomology during recent years has greatly increased, and beneficial results have been obtained in many lines of work, while several new and important branches of investigation have been entered upon.

THE MEXICAN COTTON BOLL WEEVIL.

The large-scale experimental work made possible by the emergency appropriation of Congress was carried on to the close of the season of 1904, and was taken up again in the spring of 1905. The territory infested by the boll weevil had unfortunately considerably increased both northward and eastward by the close of the season of 1904, at which time it covered approximately 98,000 square miles in Texas and Louisiana.

EXPERIMENTAL FARMS.

The territory in question probably exhibits as great variation in rainfall, temperature, and other particulars as any area of like size in the United States. Therefore it was necessary to establish fourteen experimental farms, where all sorts of experimental work were carried on. The adaptability of the weevil to new conditions, as has been shown by its having acquired an ability to become perfectly acclimated in the United States, is also witnessed in local variations due to climatic and other conditions. The general cultural method was tested in these various localities, as well as the benefit of planting selected varieties, of fertilization, and of thorough cultivation to accomplish the same result and at the same time to cover the infested squares with earth. Important and suggestive conclusions were reached which will have an important bearing on modifications of the general system.

LABORATORY WORK.

Much work was done at the laboratory with various remedies proposed for the boll weevil, including Paris green, which at one time attracted great attention. Experiments were also performed with the object of discovering feasible means of destroying weevils in cotton seed and other articles. Over 220,000 experiments were made during the past year. These dealt with dissemination, natural control, habits, various features of hibernation, and other points. A careful record is kept of the condition of the weevils on the experimental farms, and these records show the exact progress of infestation during each season. Consequently the causes that have contributed to a sudden increase at any time can definitely be determined, and this work therefore has a direct bearing upon the possibility of reducing the damage by the pest. Especial attention was paid to the possible effect of birds in controlling the boll weevil, and large numbers of birds' stomachs were collected and their contents carefully examined. In connection with the laboratory work experts were sent to watch the advance of the pest along the northern and eastern portions of its range. This has resulted in a great amount of information as to how the pest reaches new regions, and furnished the basis for publication of maps showing the territory infested.

COOPERATION WITH THE LOUISIANA CROP PEST COMMISSION.

This cooperation was continued and an energetic attempt was made by the State to check the further advance of the weevil. Five experts were placed at the disposal of the State authorities, and were stationed at various points where the progress of the weevil could best be investigated. While the Louisiana authorities did not succeed in checking the advance of the weevil, many important features of the dissemination of the pest have become well known, and the knowledge gained will be of direct benefit to other States which may at any time attempt to prevent invasion by the pest.

It has been known for some time, as pointed out in publications of the Bureau of Entomology, that the late summer and autumnal work of the cotton-leaf caterpillar is detrimental to the progress of the boll weevil. The early fall destruction of the leaves, when this is at all complete, exposes the boll weevil to the action of the sun, which is inimical to it and deprives it of its food supply. The extensive defoliation of the cotton crop in September and October, 1904, in Texas is in a measure responsible for the late start of the boll weevils in the summer of 1905. In Louisiana this phase of the cotton question is much more marked than in Texas. The cotton caterpillar is present every season, and planters generally poison against it. If the late poisonings are omitted and the caterpillar is allowed to increase,

the dense foliage of the cotton plant, which is so abundant in the moist bottom lands of Louisiana, will be done away with and the autumnal ravages of the weevil decidedly checked. In this fact lies possibly a practical measure of considerable importance.

COOPERATION WITH THE TEXAS STATION.

Two experts were stationed at the Texas Agricultural and Mechanical College and under the direction of the State entomologist made careful studies of other insects injuring cotton.

POSSIBILITY OF CONTROLLING THE WEEVIL AT GINS.

It has been evident for some time that gins have been very important factors in disseminating the boll weevil, and during the year this subject has been investigated very carefully. An especially trained expert was employed in this work, and a large number of experiments were carried on with gins in actual operation. Important results were obtained, and a series of recommendations have been sent to all ginners in the infested territory, by the observance of which, and at no very great expense, the danger existing from these establishments may be totally overcome.

INSPECTION OF FARM PRODUCTS QUARANTINED AGAINST BY STATE LAWS.

Nearly all of the cotton-growing States quarantined against certain products of Texas, on account of the danger of introducing the weevil. Some of the rules operating under State laws were too stringent, and at the suggestion of the Bureau they were modified by several States in order to permit the shipment of such products as should be certified by the Bureau as not dangerous.

THE COTTON BOLLWORM.

An investigation of this dangerous insect carried on and concluded within the past few years has resulted in the ascertaining of a complete knowledge of its habits and life history and in the elaboration of a system of treatment which will reduce its ravages in the southern cotton fields to a minimum. The investigation has been concluded and the final report published. The work that is still being carried on with regard to this species is demonstration work undertaken to show cotton planters on a large scale that the recommendations of the Bureau are sound.

THE INTRODUCTION OF BENEFICIAL INSECTS.

Very important results have been gained in the introduction of beneficial insects. One of the most striking of these results is the importation and establishment of the fig-fertilizing insect of south Europe.

This was established at Fresno, Cal., with almost immediate results of great interest. A properly planted orchard had existed at that point for some time, but efforts to import the fertilizing insect had failed. As a result of the Department's efforts, the insects were brought over alive and were thoroughly established, enabling, after one year, the production of 10 tons of Smyrna figs of a quality slightly superior to those imported from Europe. The crop has continuously increased, new orchards of Smyrna figs have been set out in parts of California, and a new industry has been established as a result of this importation.

The black scale has for many years been a serious enemy to the citrus and olive crops of California, and although a ladybird enemy of the scale had been imported from Australia, it was efficacious only in certain portions of California, not thriving in other portions where these crops have a great monetary value. After several unsuccessful attempts to establish a parasite, known as *Scutellista cyanea*, from Italy, it was found that this species also inhabits South Africa, and from that point specimens were introduced which at once took hold in California and have multiplied with such rapidity as to prove of enormous benefit to the growers of oranges, lemons, and olives.

The native home of the San Jose scale was found by one of the experts of the Bureau to be northern China, and from that point he secured specimens of a ladybird, known as *Chilocorus similis*, which were brought to Washington, propagated in numbers, and sent out to different portions of the United States infested by the San Jose scale. The insect does not seem to do well in the Northern States, but has become established in the Southern States. It is prolific and will probably maintain itself and become more and more useful every year. The lime, sulphur, and salt wash and other remedies for the San Jose scale, however, have proved so efficient and are so cheap as to be practically universally adopted, and this adoption takes away the possibility of a very rapid multiplication of the imported ladybird.

An interesting antlike insect, known as the "kelep," was discovered in 1904 in Guatemala by an officer of the Bureau of Plant Industry, and was found to be such an important enemy of the cotton boll weevil in that country as to hold it distinctly in check and to permit the cultivation of cotton where otherwise it would be impossible on account of the weevil. Colonies of this insect have been introduced into the United States, and while it is as yet impossible to state whether it will establish itself and become an important feature in cotton cultivation, it promises good results, and the fact has at least been established that in tropical regions it may be used to very great advantage.

A systematic effort has been begun within the past summer to

import the European and Japanese natural enemies of the gypsy moth and the brown-tail moth. The Chief of the Bureau visited Europe and secured very many parasites and sent them to Massachusetts, where they are being cared for. The trip has demonstrated effectually that the natural enemies of these two important insect pests may be easily brought from Europe to the infested territory in the United States, but it is as yet too early to state whether they will establish themselves in such a way as to afford relief. The outlook, however, is hopeful.

THE SENDING OF USEFUL INSECTS ABROAD.

During this period many sendings of important parasitic and predatory insects have been made to foreign countries where it was thought they would be of assistance in warfare against injurious insects. The most striking instance of the value of this work occurred in 1898, when the orange groves of Portugal were threatened with extinction by the ravages of the white scale. The officials of the Portuguese department of agriculture appealed for assistance, and through the cooperation of the State board of horticulture of California specimens of *Novius cardinalis*, the ladybird enemy of the white scale, imported from Australia into California by an employee of the Bureau some years previously, were secured. The Entomologist had these specimens carried in the refrigerating compartment of a steamer to Portugal. The success of the experiment was almost immediate and very great, and the scale was practically annihilated in a little more than a year.

Parasites of American scale insects have been, and are still being, sent to the official entomologists of Italy, France, and other countries, and good results are constantly being secured. No results, however, have as yet proved as striking as those in Portugal, just described.

WORK ON SCALE INSECTS.

Careful investigations have been made into the habits and life histories of very many species of injurious scale insects, and the Bureau has built up what is probably the largest collection of these insects in existence. Its publications on the life histories of these insects are standard, and its especial publications on the San Jose scale are the basis of all of our knowledge of this important pest. The work of the Bureau on remedies for scales has been very extensive, and for the past eight years has formed an important part of the output of the Bureau. Nearly all of the standard remedies against this class of insects are the result of these labors.

When various foreign governments passed regulations forbidding the importation of American plants and fruits, on account of the

danger of introducing the San Jose scale, some of the edicts went too far, and forbade the importation of unpeeled American dried fruits. An important investigation was therefore carried on to determine the effect on the San Jose scale of the different methods in use in this country in drying fruits for exportation. The results showed the unnecessary nature of the foreign regulations, not a single scale having been found which showed the slightest signs of life after drying by any of the processes in use. The result of this investigation was of distinct benefit to dried-fruit exporters, and necessitated the revision of the laws of several foreign countries.

INSECTS INJURIOUS TO FRUIT AND FRUIT TREES.

While scale insects form many of the important enemies of orchards, there are many others which have also been investigated. In 1901 the necessity developed for a careful investigation of the codling moth in the Northwestern States, where it seemed the remedies applied in the East were not effective. It was supposed that the difference in climatic conditions had brought about a change in the life history and habits of the insect which rendered eastern remedies less useful. Consequently a thorough investigation was carried on, which lasted for three years and cleared up all doubtful points in life-history conditions as applied to the Northwest, and resulted in the publication of results which have been of great value to the fruit growers of that region. In the course of this investigation demonstration work was carried on in one of the largest orchards in Idaho, and fruit growers from different parts of Washington, Oregon, and Idaho were invited to inspect the methods and the results. Many did so, and were convinced of the value of the work. Fruit growers in California and other States have written to the Department stating that their operations had been rendered much more profitable as the result of this investigation.

While more or less work against fruit insects has been constantly carried on, an effort has been organized to make a very especial and widespread investigation of this class of pests, and several experts have been assigned to the work, which is now being carried forward on a broad scale.

INSECTS DAMAGING FORESTS.

Beginning with 1899, an investigation of the damage to forests by the work of insects was begun by the Bureau of Entomology in co-operation with the Bureau of Forestry. The importance of these investigations was immediately recognized, and they have been extended until they form a distinct section of the Bureau's work. Many important results have been reached. In 1902, for example,

great loss of pine timber, to an amount of more than 226,000,000 feet (board measure), was found to have resulted in the Black Hills Forest Reserve from the work of a bark beetle mining under the bark of living trees.

An investigation resulted in the discovery of practical methods by which the ravages may be entirely checked. The cost of carrying out the recommendations is not great, and the investigation means not only the saving of threatened loss of forest property valued at many millions of dollars, but also the prevention of the crippling of great mining and commercial enterprises representing many more millions. In the course of this work especial cooperation has been entered into with lumbering companies, manufacturers of wooden articles of trade, importers of exotic woods, and forest rangers, which is rendering the work more efficient and bringing it close to the people directly interested in its results.

INSECTS INJURIOUS TO STORED FOODS.

An extended investigation has been made of insects injurious to stored foods. The full life history of practically every species known has been worked out, extensive experimental work has been carried on with remedies, and a thoroughly practical and efficient system of fighting these insects has been ascertained. The publications of the Bureau on this class of insects have been in great demand among grain and milling men, and the efficacy of the Bureau's recommendations is undoubted. The number of species of insects which infest stored food supplies is very great, and the labor of working out the full life histories has been prolonged and arduous.

INSECTS WHICH CARRY DISEASE.

Special and important studies have been made of certain of the insects known to carry disease, with results of great importance. The publications of the Bureau on the subject of mosquitoes have been in great demand by members of the medical profession, and to a large extent the knowledge we have in this country of the mosquitoes which carry malaria has been due to the work of this Bureau. Important studies have also been made of the yellow-fever mosquito, and the quarantine regulations of the Public Health and Marine-Hospital Service, in the recent yellow-fever emergency, are based on the results of this work. The Bureau was a pioneer in work against mosquitoes, and its constant reiteration of the possibility of controlling mosquitoes has been in a large measure the cause of the large-scale antimosquito work now being carried on.

The Bureau has also paid special attention to the study of the house fly, especially in relation to its agency in the carriage of disease.

These studies revealed the very great danger that exists of the carriage of typhoid fever by the house fly and by certain other insects. This investigation is the only one of its kind that has ever been carried on, and its results are considered of great value by the medical profession.

INSECTS AFFECTING LIVE STOCK AND FIELD CROPS.

Studies of the insects affecting live stock have been continued, and new material of value has been published about several of the more important. An investigation into the natural history of the cattle tick is now being carried on, which will have an important bearing on the cattle industry of the South, since upon such an investigation may depend the important question of rotation in pasturage to do away with the so-called Texas, or splenetic, fever.

Careful studies have been made of a number of the principal field-crop enemies of the country, and as a result special bulletins were published on the Hessian fly, on the chinch bug, and on the general subject of insects injurious to grains and grasses.

SILK CULTURE.

In 1902 the Bureau began once more, after an interruption of a number of years, a systematic effort to introduce the culture of the domestic silkworm into the United States, and this effort has continued since that time. Guaranteed eggs were purchased in Italy, mulberry cuttings of best varieties were also purchased abroad, manuals of instruction in the raising of silkworms and in the care of silkworm food plants were issued, and two silk reels purchased in France. Two skilled French reelers were brought over from France, and remained in Washington for some months instructing several American girls in the process of reeling thread from cocoons. The eggs purchased abroad were sent, on application, to all persons in the United States who possessed mulberry trees, upon the leaves of which the worms are fed. Persons not possessing mulberry trees were supplied with cuttings, rooted seedlings, or seed of the mulberry.

Following the instructions given in the manuals, the correspondents of the Department raised their silkworms, harvested their cocoons, and sent them to the Department, for which they were paid the current European prices. The cocoons were then reeled by the Department's employees, and the silk resulting will eventually be sold. This process has been repeated each year. The establishment of commercial filatures in the United States without a guaranteed crop of cocoons is obviously an impossibility. Therefore it has been the aim of the Department to get mulberry trees planted in favorable situations, to educate as many people as possible in the care of the worms, and, by purchasing the cocoons, to keep its correspondents interested

and engaged in the culture until the time comes that the establishment of commercial filatures will be possible. The recent invention of silk reels which greatly reduce the cost of reeling and the establishment of colonies of Italians and others skilled in silk culture at different places in the United States seem to point to the establishment of the industry before long.

WORK IN APICULTURE.

There have been carried on during the period mentioned certain investigations in bee culture which have in the past year become extended and which promise to be of much assistance to the keepers of bees in the United States. The lines of work being carried out are principally in the studies of bee diseases, in the investigation of new forage crops, and in the introduction and establishment of valuable races of bees from other parts of the world.

OTHER INVESTIGATIONS.

A number of investigations of scarcely less importance than those mentioned have been undertaken and completed, or partly completed, during the past eight years. Important studies have been made of injurious insects liable to be imported from other countries, and these studies are valuable from the fact that injurious insects from abroad are constantly being brought in. The ready recognition of such imported pests is necessary, and as the result of these studies several recently imported insects of menace to agriculture have been recognized and stamped out.

Extensive studies have been made of insects affecting truck crops, and many bulletins giving remedial measures have been published.

Insects affecting tobacco have been studied with care, and the results published. The same may be said of insects affecting gardens and greenhouses.

Every year a tour of investigation throughout the Western States has been made by an expert to study the grasshopper conditions and to be able to predict the locality of any threatened outbreak. Careful experiments on a large scale were carried on with a fungus which kills grasshoppers reported to be very successful in South Africa. The results of this investigation were negative, owing to the climatic conditions which prevailed in parts of the West in which grasshoppers abound.

A great deal of work of a systematic character in the study and classification of insects has been done. Entomologists of the agricultural experiment stations and others rely upon the Bureau for work of this kind. The large force of experts in the employ of the Bureau and the possession of large collections and a large library at

Washington render this a center for inquiries of this class. The amount of time employed in this work is very great, but the results are of value in an indirect way, since they assist in the labors of the station entomologists and render them more accurate. Along the same line a careful bibliography of all published matter relating to American economic entomology has been kept up and has been published from time to time for the use of American economic entomologists and others.

Careful work has also been done on the geographic distribution of injurious insects, indicating the spread of imported species and the portions of the country inhabited or not inhabited by every injurious insect of first-class importance.

SAVING FROM INSECT LOSSES RESULTING FROM THE WORK OF THE BUREAU.

Some indication of the cash value of the work outlined should be given.

The boll weevil, which in 1904 caused the destruction of \$22,000,000 worth of cotton in Texas, did not prevent, in that year, the production of the largest cotton crop grown in this State, and the very regions where the crop in the earlier years of the invasion of the weevil had been utterly destroyed produced cotton this year in very profitable quantities. The enormous cotton crop of Texas for 1904 affords an evidence of the value of the methods of control elaborated by this Bureau. In the case of the bollworm, which has caused a loss annually of about \$12,000,000 throughout the cotton-producing area of the South, the careful experimental field work of this Bureau has shown means of preventing a very large percentage of this loss, and these means of control are being gradually adopted, to the great profit of cotton growers.

The methods of controlling the San Jose scale, the most important pest of the deciduous fruit trees in this country, are so effective that commercial orchard growers no longer fear this scale insect. The proof of the efficiency of these methods and their general exploitation have largely come about within the last eight years, and chiefly as the result of the experimentation conducted by the Bureau of Entomology. The saving effected amounts not only to millions of dollars in value of the fruit product, but also to the very life itself of the trees and the continuance of large commercial orchard enterprises. The cost per tree of this treatment is not heavy, but it is expected that this charge will be still further reduced by the importation of natural enemies of the San Jose scale.

The saving which has already resulted from work against the insect enemies of forests is illustrated by the outcome of the investigation in the infested Black Hills district. Here a loss of more than

\$10,000,000 worth of timber occurred in a single year. Simple and effective means of preventing repetitions of such losses were discovered.

In the case of stored products, such as cereals, tobacco, and woolen and manufactured goods, the processes of fumigation with bisulphid of carbon and hydrocyanic-acid gas, which have come into general use during the last eight years, are preventing enormous losses every year. The annual loss in stored products is probably fully 5 per cent, which gives the enormous total of \$100,000,000, and certainly one-half of this loss can be prevented by the proper use of the fumigants mentioned. These same fumigants are also coming into very common use for the eradication of insect pests in houses and stores, and the saving in this field is already very great.

The lessening of the diseases due to mosquitoes and house flies, such as malaria, typhoid fever, and yellow fever, has been very greatly assisted by the investigations of the breeding habits and means of controlling these pests conducted by the Chief of the Bureau of Entomology. The cash value of such work is almost beyond computation when the stagnation of business enterprises and general commerce which results from epidemics of yellow fever and, to a less extent, of typhoid fever and malaria, is considered. The same is true of insect parasites and disease conveyors affecting domestic animals.

Many other items of equal importance could be added relating to field-crop insects and insect enemies of fruits and other farm and orchard products. In the case of the latter more particularly the benefits resulting from the work of the last eight years have been in continuation and accentuation of work of earlier years, but a good share of the present benefits must be ascribed to the increased effectiveness and knowledge gained by the more recent investigations.

BUREAU OF BIOLOGICAL SURVEY.

The work of the Biological Survey began in 1885, and at first consisted chiefly of the study of the food habits of birds and mammals for the purpose of determining their exact relations to agriculture.

A second line of investigation was soon added, for it was perceived that the distribution areas of indigenous plants and animals were closely correlated with those of cultivated crops. The determination of the boundaries of the natural life zones of the United States and the corresponding crop zones, therefore, became an important division of the work of the Survey.

In 1900, as a result of the passage of certain Federal laws, a third division of the work, that of game protection and introduction, became necessary.

The work of the Survey is now pursued along these three distinct lines.

DETERMINATION OF LIFE ZONES AND CROP ZONES.

Early attempts at agriculture in the United States were necessarily almost wholly experimental, and the particular locality, climate, and conditions suited to special crops were ascertained only after many and costly individual trials. The chief purpose of a biological survey of the several States is to ascertain and make known, by means of maps and reports, the boundaries of the natural life zones, together with the physiographic and climatic conditions that determine them. The life zones of a State once ascertained with precision, the farmer is greatly aided in selecting the crop best adapted to his own district and, what is scarcely less important, in avoiding crops unsuited to it. Thus the uncertainty and cost of farming experiments may be greatly reduced.

In a publication entitled "Life Zones and Crop Zones of the United States" the life zones of the country were defined and mapped, and the adaptation of various crops to the several zones were indicated so far as the data collected to 1898 permitted. Future and more detailed work in the several States will enable the life zones to be defined with greater precision and the selection of crops to be made greater accuracy.

Biological field work in the State of Texas, which was begun in 1899, has been completed and final reports are being prepared. A report already published contains an account of all the mammals and reptiles of the State, with especial reference to their economic status. The life zones of the State are defined and, as a means of identifying them, the mammals, birds, reptiles, and plants characteristic of each zone are specified.

A biological survey of California was begun in 1891 and is far advanced toward completion. Its size, peculiarly diversified surface, its mountains and deserts, and its climatic conditions render California a difficult field for biological surveys, while the varied resources of the State and its immense agricultural interests make the work exceedingly important.

Work in outlining and mapping the life zones of Colorado and New Mexico along lines similar to those indicated above was begun in 1904, and is progressing satisfactorily.

Preliminary work has been carried on in most of the States whose agricultural interests are large, and detailed surveys of the several States will be undertaken as rapidly as means and the exigencies of work already begun permit.

Investigations in Alaska were begun in 1899, when the increase of population and growing commercial importance attracted attention to that Territory. Little accurate information was then available regarding the game and fur-bearing animals which add so

largely to the resources of the region. Moreover, important problems connected with the study of the life zones and crop zones of the United States could not be solved satisfactorily without contributive data from more northern regions. An assistant, therefore, has been engaged in field work in Alaska each season since 1898, excepting 1901 and 1905, and the results are found to have an important bearing upon many phases of the work of the Biological Survey. Of particular value has been the direct knowledge of local conditions thus obtained, which is necessary for use in connection with the administration of the Federal game law of Alaska. A part of the results of these investigations has been published in three faunal reports. Other reports of similar nature are in preparation.

From 1900 to 1903 a small party of the Survey was engaged in studying the geographic distribution of birds, mammals, and plants in the Boreal and Arctic zones of Canada, particularly for the purpose of connecting the results of work in Alaska and the home territory by means of investigations in the intervening regions. Part of the results appeared in 1902 under the title "A Biological Investigation of the Hudson Bay Region," and a report upon the work in the Athabasca and Mackenzie valleys is nearly ready for publication.

In 1897 the work of the Survey was extended into Mexico for the purpose of tracing into that country the life zones of the United States, to determine the northern limits of the tropical zone of Mexico, to ascertain its extent within the United States, and to obtain a knowledge of the distribution, abundance, and habits in Mexico of American plants, birds, and mammals. A general zone map of Mexico has been completed, and a large amount of scientific and economic data is on file.

ECONOMIC ORNITHOLOGY.

This section of the Biological Survey is engaged in the study of birds in their various relations to man. Two principal lines of investigation are followed. In the first, the habits of birds are studied in the field, especially with reference to their food. Orchards, gardens, and grain fields are visited in order to determine whether birds damage crops, attacks insects, both injurious and beneficial species, and to what extent they feed upon wild fruits and weed seeds. In this field study it is desired to enlist the cooperation of every cultivator of the soil. In the second, stomachs of birds are examined in the laboratory and their contents tabulated. In addition to the stomachs collected by our own assistants, many are obtained from ornithologists throughout the country. From 1885 to 1897, 24,000 stomachs had

been collected, and of these about 12,000 had been examined. Since then stomachs have been received at an average rate of more than 4,000 annually, and the number is constantly increasing from year to year. The total number now on hand is about 66,000.

In 1903 an article was published upon the "Economic Value of the Bobwhite," in which the salient points in the food habits of this valuable bird were brought out. Attention was paid also to birds in their relation to bee culture, as complaints had been made that birds destroy bees.

In 1904 a preliminary article upon the work in California, begun in 1901, was published, in which the conditions attending fruit growing in that State were briefly reviewed and the birds of economic interest were discussed.

The constantly increasing ravages of the cotton boll weevil have created an urgent demand for accurate knowledge of the food habits of insectivorous birds in the cotton districts, and during the past two seasons assistants of the Biological Survey have made a special study of birds in relation to the destruction of the boll weevil. As a result of these investigations a bulletin on the subject has been published, and considerable additional data have been gathered.

ECONOMIC MAMMALOGY.

In connection with the study of the geographic distribution of mammals, field naturalists are instructed to observe particularly the food habits of each species, to secure data concerning their relation to the farmer, whether beneficial or injurious. Many stomachs have been examined and others are now on hand awaiting examination.

During the past eight years experiments in the use of poisons and other means for destroying noxious mammals have been made, both in the laboratory and in the field. Rats, prairie dogs, ground squirrels, rabbits, field mice, and pocket gophers have been the subjects of these experiments.

Special reports on prairie dogs, ground squirrels, pocket gophers, jack rabbits, and coyotes have been published, and investigations concerning these and other mammal pests are being continued. A great mass of notes on the habits of mammals has been accumulated, and reports on the economic relations of field mice, beavers, wolves, and skunks are now in course of preparation.

Experiments with fences to protect sheep and other domestic animals from the depredations of coyotes, dogs, and other predatory animals are in progress in cooperation with farmers in Oklahoma and Kansas.

GAME PROTECTION AND INTRODUCTION.

The duties of the section of the Biological Survey devoted to supervision of game protection and introduction grow out of three acts of Congress: Act of May 25, 1900, commonly known as the Lacey Act, requiring supervision of importations of wild birds and animals from foreign countries and of the preservation of the birds and game of the United States; act of June 3, 1902, requiring supervision of the importation of eggs of game birds; and act of June 7, 1902, requiring supervision of the preservation of the game of Alaska.

ENTRY OF FOREIGN BIRDS AND ANIMALS.

Since the passage of the Lacey Act, May 25, 1900, constant vigilance has been exercised to prevent the entry of injurious species of birds and mammals. The annual importations of birds and animals are large, and include canaries and miscellaneous cage birds, shipped mainly from Germany, Australia, China, and Japan; a few pheasants and other game birds, for liberation or confinement in aviaries, and rare birds and animals for the various zoological parks of the country, brought in chiefly at New York and San Francisco; pheasants for aviaries imported from Canada at ports along the northern border, and parrots and monkeys from Mexico and Central America, entered at southern ports. Inspectors have been appointed at seven of the principal ports to examine all large shipments or such as may possibly contain injurious species.

During the five years ending June 30, 1905, 1,591 permits have been issued for the entry of 1,006,964 birds (principally canaries), 2,846 mammals, and 38 reptiles, and 13 for the entry of 6,500 eggs of game birds. Of the consignments entered 402 have been inspected. To prevent inconvenience in cases where no danger exists, the requirement of permits for reptiles and a number of species of well-known mammals was removed at the end of the first quarter of the operation of the law. So far as is known, no injurious species have been entered. Seven mongooses, 54 flying foxes or fruit-eating bats, 1 kohlmeise, 15 blaumeisen, and 2 starlings have been refused entry, and either killed or reshipped to the original port of shipment. Six keas were refused entry at Honolulu.

INTERSTATE COMMERCE IN GAME.

Through cooperation with the Department of Justice and game officials throughout the United States 166 violations of the Lacey Act, involving the shipment of 24,424 head of game and 2,608 plume birds, have been investigated, and 49 convictions have resulted. Of the convictions 30 were secured in Federal and 19 in State courts.

In addition to securing convictions for violations of law, great effort has been made to secure observance of both the Federal and State laws. Summaries of the principal provisions of the game laws of the United States and Canada have been issued annually and widely distributed, and several publications on special subjects have been prepared.

Aid in framing satisfactory laws has been extended to State officials and legislators; the conditions of illegal traffic in game have been carefully studied and in special cases have received personal investigation, and copious correspondence and many personal interviews have been had with State game officials with a view to securing better legislation and more rigid observance of the laws. To this phase of the Department's duties railroad and express companies have lent cordial and valuable cooperation.

PROTECTION OF GAME IN ALASKA.

Thorough supervision of game protection in Alaska has not been possible because of the limited means available for this purpose. With the cordial cooperation, however, of the Treasury Department, through its customs officials at Port Townsend, Seattle, San Francisco, and various points in Alaska, a rigid surveillance has been maintained of all exports of game trophies and specimens from the Territory. During the three years the law has been in operation 155 permits for such exports have been issued, under which 93 trophies were shipped, including heads of 29 moose, 38 sheep, and 3 caribou, as well as several consignments of specimens for scientific purposes. Owing to expressed local dissatisfaction with the law a bill materially modifying it was introduced into Congress in the session of 1904-5. For this reason it was deemed desirable to further restrict the issue of permits, and very few have been granted during the present year.

BIRD RESERVATIONS.

It is well known that certain favorable localities form breeding places for large colonies of birds. Such localities offer tempting marks to those who gather eggs or plumage for commercial purposes, and if these depredations are unchecked complete extermination of certain species is sure to result. Within the past three years three such breeding grounds have been converted by the President into bird reservations. Pelican Island, a breeding resort for pelicans, off the coast of Florida, was so set apart on March 14, 1903; Breton Island and two smaller islands off the coast of Louisiana, a breeding ground for gulls and terns and a wintering resort for hundreds of thousands of ducks, were reserved on October 4, 1904, and four small islands in

Stump Lake, North Dakota, which form a breeding colony for many ducks and other water birds, on March 9, 1905. The Department cooperates in the establishment and regulation of these reservations.

ACCOUNTS AND DISBURSEMENTS.

In this Department the keeping of accounts and disbursement of funds are assigned to the Division of Accounts and Disbursements. The report of the Chief shows the work of the Division to be in good shape. Of the \$6,094,540 appropriated by Congress about \$800,000 remained unexpended at the close of the fiscal year, but most of this sum was covered by liabilities. The accounts for 1903 have been finally closed, and an unexpended balance for that year of \$281,615.16 has been covered into the Treasury.

The estimates for the current fiscal year (1906) amounted to \$5,697,810, of which \$1,388,490 was for the Weather Bureau. It should be stated that the estimates and appropriations mentioned here do not in any case include the \$720,000 annually appropriated for the support of the State Agricultural experiment stations. Congress made small reductions in many of the estimates, but large increases in several others, so that the total appropriations exceed the estimates by \$292,880. This increase does not include \$190,000 appropriated for continuing the cotton boll weevil investigations, nor \$950,000 appropriated for the new Department buildings, which subjects were not included in the Department's estimates. The large apparent increase in appropriations for salaries resulted mainly from the fact that employees formerly paid from "lump-sum" funds have been placed on statutory rolls. The largest actual increase was one of \$330,180 in the appropriation for the Forest Service, which resulted chiefly from the transfer of the National forest reserves from the Interior Department to this Department.

DIVISION OF PUBLICATIONS.

THE WORK OF PUBLICATION.

At this time, when the publication work of the Government is the subject of considerable discussion and not a little criticism, it is meet and proper that this branch of the work of this Department should be presented clearly to the public.

DIFFUSION OF INFORMATION AUTHORIZED BY LAW.

In the organic law which created this Department it was made the duty of the head of the Department to diffuse just as much as to acquire information of value to agriculture. While the Secretary is authorized to diffuse this information by all means at his command, the most obvious method, the most economical, the most available, is

to put this information in print. Inasmuch as the acquisition of any information of value to agriculture imposes on the Secretary the duty of making it public, it is obvious that the work of publication must grow with the growth of the Department. Every line of inquiry authorized and undertaken by the Department implies necessarily the publication of results.

GROWTH OF PUBLICATION WORK.

Under the circumstances it is not surprising to find that whereas in 1897 the total number of publications was 424, in 1905 the total number was 1,072, and whereas in 1897 the number of printed pages of original matter was 11,715, in 1905 the number of printed pages of original matter was 20,000. The unavoidable growth of the publication work of the Department has been from the first the subject of my earnest consideration, and every effort has been made toward economy consistent with the duty presented above of making speedily available to the public whatever valuable information has been acquired. The practice has been adopted of restricting the size of the editions as much as possible with a view to preventing the accumulation of undistributed publications, and reprints have been resorted to from time to time in the case of publications for which a continuous demand was found to exist. Especially has this been true of publications of a technical character.

WATCHFULNESS IN THE DISTRIBUTION OF PUBLICATIONS.

Objections have been urged against the publication and distribution by this Department of bulletins of a technical character. The answer to these objections is that many of our publications are unavoidably scientific or technical in their character, being the practical record of scientific investigations by scientific men, the value of whose conclusions must necessarily bear the scrutiny of scientific investigators the world over. The elimination of all scientific terms and language from such reports is impossible. In this connection it is well to call attention to the fact that the average edition of these more technical or scientific publications is about 2,000 copies, and distribution to others than specialists, libraries, and educational institutions is very insignificant. For popular use the great bulk of publications has appeared in the form of inexpensive pamphlets, such as, for instance, the Farmers' Bulletins, which constitute nearly one-half of the total number of publications issued. Every possible care is taken in the distribution of our documents to minimize the waste inseparable from any system of gratuitous distribution.

The permanent lists of the several Bureaus, Divisions, and Offices are kept within as narrow bounds as possible, the policy of the

Department being to widely advertise its publications as they appear and confine the distribution almost entirely to persons applying for them. A fair test of the demand for the Department publications is furnished in the records of the Superintendent of Documents, from whom the publications of the Department may be obtained by purchase. This official reports the sale during the year 1905 of 68,000 Government publications, of which more than 38,000 were publications of this Department.

FARMERS' BULLETINS.

Of the Farmers' Bulletins there were distributed upon the orders of Senators, Representatives, and Delegates in Congress 4,782,643 copies during the past year. Unlike the Yearbook and other publications of the Department especially ordered by Congress, the Farmers' Bulletins are not delivered to the folding rooms of the Senate and House, subject to the order of members, but are held in this Department and are distributed mainly under addressed franks furnished by them. Moreover, under the law providing for this class of publications, all those remaining on hand of the 80 per cent provided for the use of Congress revert to the Department and are thus made available for redistribution.

One feature of the Congressional distribution deserves to be specially noted, and that is that the proportion of Senators, Representatives, and Delegates failing to use their quotas is very much less than heretofore. The fact that the number of Farmers' Bulletins left over from the 1st of July last was less than the year previous by over a million copies has resulted in a reduction of the Congressional quota of the current year from 15,000 to 14,000 copies.

THE YEARBOOK.

The Yearbook of the Department is published annually in an edition of 500,000 copies, as provided by the act governing the public printing and binding approved January 12, 1895. Of this enormous edition, however, but 30,000 copies are placed at the disposal of the Secretary of Agriculture, and of this number 27,000 or 28,000 are reserved and sent to active correspondents who have in some way earned, by actual services rendered, a right to such recognition, leaving the number in the hands of the Secretary for miscellaneous distribution but about 2,000. It may be stated here that the total number reserved for the Department, namely, 30,000, is just the same as it was twenty years ago, when the total edition was 300,000. Of the 200,000 additional copies printed since then not a single copy finds its way to the Department itself, and every business day of the year scores of letters are written by the Department explaining

to applicants, including even those who have certain claims upon the Department, our inability to supply them with the Yearbook; this notwithstanding that, as has been recently shown, thousands of copies remain stored in the folding rooms of the Senate and House undistributed and unavailable—a condition of things, however, which it is obvious the head of this Department is powerless to affect. Investigation would probably show that a similar condition exists in regard to many other of the publications printed by order of Congress and reserving a considerable quota for Congressional use.

- A FRUITFUL SOURCE OF EXTRAVAGANCE.

The provision of the law already cited, which limits to an edition of 1,000 copies all publications of this Department exceeding in size 100 octavo pages, has proved a fruitful source of extravagance. While designed, undoubtedly, merely to effect the limitation of our publications to small-sized pamphlets, a limitation which it has been the general policy of the Department to encourage, the actual effect has been to compel application to Congress for a larger edition, such action almost invariably involving provision for several thousand copies for the use of members, and this even in cases such as the Beet Sugar Reports, where only a minority of the members was interested in the subject. Some of these publications have been printed and reprinted by order of Congress, such as the Report on the Diseases of the Horse, and the Report on Diseases of Cattle, and others, the total editions in some cases aggregating hundreds of thousands of copies, where no application for such provision was ever made by this Department, and in many cases where no provision was made for a single copy for the use of the Department.

From the foregoing it is obvious that in the matter of printing this Department occupies a unique position, it being the Department's special duty to print, and to print abundantly; that in the aggregate nearly one-half of all the copies of its publications are issued subject to the order of Senators and Representatives; that economy is practiced both as to style of publication and in the manner of distribution; that a determined effort is made to restrict the number of copies of the publications of the Department to the actual demand existing for them.

The total number of documents distributed was 12,089,653 copies, the actual mailing, correspondence, and clerical work in connection therewith involving work of considerable magnitude and difficulty. It is gratifying to report, however, that the distribution has been unusually prompt, the average length of time required in filling miscellaneous requests for publications having been reduced to an average of two days. This result has been rendered possible largely owing to increased facilities and improved service.

DEMAND FOR PUBLICATIONS FROM EDUCATIONAL INSTITUTIONS.

Unfortunately, under the limitations imposed upon the Department either by the printing law or the available appropriations, the actual demand for publications is far beyond our ability to supply. A very large proportion of the correspondence of the Division of Publications consists of letters explaining our refusal to comply with what seem to be perfectly reasonable requests for Department publications. One feature of this demand deserves special notice. Of late years the demand made upon us for publications in bulk for class work in institutions of learning, for use at farmers' institutes, and from others of the very numerous and rapidly increasing agencies seeking to promote agricultural education has multiplied tenfold. While this is a most encouraging feature from an educational and sociological point of view, it is truly discouraging to be able to meet only a very small proportion of these demands, and rarely to be able to comply with any of them in their entirety. It is of no use to allege the existence in large numbers of undistributed publications of this Department in the folding rooms of the Senate and House, this supply being entirely beyond the reach of the Department, and serving only, as its existence is reported from time to time in the public press, to stimulate demands upon the Department and to make more difficult to the minds of many applicants our explanations of inability to satisfy their requests.

INDEXING THE PUBLICATIONS.

One of the important features of the work of the Division of Publications recently established on something like an adequate basis is that of a general and comprehensive indexing of all the publications of the Department. It is of the utmost importance that this indexing scheme should be fully carried out in regard to all of our publications—past, present, and future. The existence of such a complete index would pay for itself over and over again.

REPORT TO JOINT COMMITTEE ON PRINTING.

This Department furnished to the chairman of the Joint Committee on Printing of the Senate and House of Representatives a statement showing the publications issued by this Department during the fourteen years ended June 30, 1905, giving the number of copies of each edition printed, the cost of each publication, the manner of distribution, and the number of copies on hand July 1, accompanied by replies to the several interrogatories contained in the request for the information furnished, together with certain recommendations in regard to the public printing and binding.

BUREAU OF STATISTICS.**THE DEVELOPMENT OF THE BUREAU.**

The statistical work of the Department of Agriculture, begun in 1862, has developed into wide use in serving as a basis in establishing prices of farm products. The relations and mutual interests of agriculture, commerce, and manufactures, and of consumers of farm products, are now so vast and so complex that the necessity of issuing impartial crop reports by this Bureau is generally recognized. The needs of all interests require that there be published at frequent intervals during the crop season by a disinterested agency reliable information of the acreage, condition, production, and value of the principal crops, also reports of live stock, by States and by total crop areas, to serve as a legitimate basis for current prices. When this work was begun the value of farms and farm equipment was about \$7,000,000,000; now it has reached nearly three times that amount. Of the \$5,000,000,000 worth of annual farm products a much larger per cent than formerly is sold off the farm and enters commerce and manufactures.

The industries depending on agriculture have grown to vast proportions, and not only manufactures, but transportation and mercantile business are in more sensitive touch with the products the farmer can sell and with his power to purchase than ever before. Trade has become vastly more complex, partly owing to the rapid development of reselling on close margins to take advantage of fluctuations in prices, and of dealing in futures and in options. The development of organizations to fix prices and of other organizations to force temporary changes in prices, giving unnatural advantages to price manipulators, has led the public more and more to recognize the need for a strong and impartial agency to make comprehensive reports of actual facts relating to prospective crops and yields, that all concerned may know how to buy and sell.

THREE CLASSES OF CROP REPORTS.

There are three classes of statistical reports of agricultural products prepared by the Federal Government.

(1) The census of agriculture, issued every tenth year by the Census Bureau of the Department of Commerce and Labor, giving a census count of all acreages and yields of crops and reports concerning farm animals, the last census having given the figures collected in 1900 of the crops and live stock for 1899. The reports of the Census Bureau, coming out one year in ten, after the crop of that year is harvested and sold, serve only as a basis and a check, making it possible for the Bureau of Statistics of this Department during the succeeding ten years to more accurately estimate amounts of crops in prospect or

amounts actually harvested. The reports of this Bureau could be made more accurate if an agricultural census were taken every five years instead of every ten, providing bases of comparison not so far removed.

(2) The monthly and annual reports by the Bureau of statistics of agriculture, giving acreage, condition, yields, and prices of crops, and reports of live stock, serve as bases for current prices.

(3) These monthly reports, expressed numerically for entire crop areas, serve also as bases for more frequent reports of changed conditions caused by marked weather changes as reported by the Weather Bureau of this Department.

CONDITIONS GOVERNING THE MAKING OF CROP REPORTS.

Various conditions govern the making of reports which influence the prices of farm products. Government crop reports deal mainly with products which are not quickly perishable. The prices of these are fixed at frequent intervals—often daily—by large market organizations, which gather information from the entire area as to the probable amount of products available, positions of any of the products on the routes of commercial movement, and the demand for the products. About these markets there are agencies which may combine to raise or lower prices artificially and temporarily, often so manipulating the prices as to destroy the needed confidence in merchandising the products, and resulting in unwarrantably large "handling charges" from the time the products leave the producer till they reach the consumer.

The producer should have as good a central crop-reporting agency as the buyer. Since his business is divided into many small noncooperative units, he can not have this without Government aid. The manufacturer, the dealer in actual products, and the consumer also need protection from the speculative manipulation of agencies organized to modify prices temporarily for their own advantage, and the main purpose of crop reports is that the whole people may be benefited by a knowledge of the actual facts which may influence current prices.

A knowledge which covers only parts of the area of a given crop may be misleading, because to judge for the entire area from conditions in some localities may give wrong results; hence the producer and others interested need a knowledge of the crop of the entire area expressed as a total. Reports covering part of an area, or covering the area definitely only in parts, may be used by self-interested crop reporting agencies to mislead. The reporting agency, in order to enable those interested as producers, consumers, or dealers to recognize the conditions in the entire crop area, must resolve all the facts into quantitative statements, preferably a single numerical statement,

as of yield for the entire area, and the market must then resolve the balances between supply and demand into current prices. Only by "weighting" reports from each district, that is, by giving to each partial report only that arithmetical weight which the acreage in the area covered by the partial report demands and assembling the whole into one statement, can the crop estimator accurately report for the whole area. Such definite forms of statement have the advantage of placing the reporting agency under responsibility to attain accuracy, also of being easily interpreted by all parties; and they are capable of comparison from month to month or from year to year or with averages, as for the previous ten years.

The Bureau of Statistics, acting as a disinterested agency, has assumed the task of keeping the farmers, the dealers, and the users of farm products informed, and the general acceptance of its estimates in deciding prices is the only proof needed to establish the reasonable accuracy of these estimates. Its reports of conditions and its estimates used by markets in establishing current prices have become a necessary part of our domestic trade and our foreign business. These monthly reports serve as guides to all intermediate reports from whatever source, which without this monthly basis would be too local and partial to be of much value, and enable producers to know the facts as to the promise of prices for their crops, that false reports—which were common before the Government arranged to give the facts as nearly as they could be ascertained—may not mislead them into early sales at prices purposely made too low.

METHODS OF CROP REPORTING.

The Bureau of Statistics issues each month detailed reports relating to agricultural conditions throughout the United States, the data upon which these statements are based being obtained through a special field service, a corps of State statistical agents, and through a very large body of voluntary correspondents composed of the following classes: county correspondents, township correspondents, individual farmers, and special cotton correspondents.

A special field service is composed of ten traveling agents, each assigned to report for a given group of States. These are especially qualified by statistical training and practical knowledge of the crops. They systematically travel over the districts assigned them, carefully note the development of each crop, and keep in close touch with best-informed opinion; and they render written and telegraphic reports monthly and at such other times as required.

The State statistical agents are paid agents located in 43 of the States. Each of these reports for his State and maintains a corps of correspondents entirely independent of those reporting directly to the Department at Washington. These State statistical aids report each

month directly to the State agent on schedules furnished them. Their reports are then tabulated and weighted according to the relative yield or area of the given crop in each county represented, and are summarized for the use of the State agent. Then he coordinates and analyzes them in the light of his own knowledge of conditions derived from personal observation and other sources, and prepares his monthly and other written and telegraphic reports to the Department.

There are in the United States approximately 2,700 counties of agricultural importance. In each of these counties the Department has a county correspondent, who maintains an organization of several assistants. These county correspondents are selected with especial reference to their qualifications, and constitute an efficient branch of the crop-reporting service. They make the county the geographical unit of their reports, and after obtaining data each month from their assistants and supplementing this with information obtained from their own observation and knowledge they report directly to the Department at Washington.

In the townships and voting precincts in the United States in which farming operations are extensively carried on the Department has township correspondents, who make the township or precinct the basis of the reports which they send directly to the Bureau of Statistics each month.

Finally, at the end of the growing season a large number of individual farmers and planters report on the results of their own individual farming operations during the year.

With regard to cotton, the information secured from all the foregoing sources is supplemented by that furnished by special cotton correspondents, embracing a large number of persons intimately concerned in the cotton industry.

SCOPE OF CROP REPORTS.

Eleven reports on the principal crops are received yearly from each of the special field agents, State statistical agents, county correspondents, and township correspondents, and one report relating to the acreage and production of general crops is received during the year from individual farmers.

Six special cotton reports are received during the growing season from the special field agents, from the State statistical agents, from the county correspondents, and from township correspondents; and the first and last of these reports are supplemented by returns from individual farmers, special correspondents, and a list of cotton ginnery supplied through the courtesy of the Census Bureau, Department of Commerce and Labor.

HANDLING THE CROP REPORTS.

It has been found necessary during the past year to thoroughly recast our methods of handling the crop reports. A gross breach of trust on the part of one of the responsible employees of the Bureau of Statistics, involving the misuse for private gain of the confidential reports to which this person had access, revealed a weak link in the chain. An entirely new method of handling the reports was devised, which it is believed makes it practically impossible for such a breach of confidence to occur in the future.

In the case referred to the prompt dismissal of the culpable official was followed by the submission to the Department of Justice of the whole matter, with a view to the prosecution of the guilty party or parties. It has thus passed beyond the jurisdiction of this Department. It is hoped that the law will be found adequate to reach this class of offenders.

This Department acted with vigor and dispatch when it got evidence of wrongdoing on the part of its own officials, but we have no evidence of disciplinary or preventive action at the traders' end of the line, where gamblers interested neither in production nor consumption disturb values to the injury of both, and make loud outcry when creatures of their own kind corrupt officials to betray confidence for the love of money. The responsibility for this "leak" is shared by everyone who, to get money without work, gambles in farm products. When this form of industry ceases these parasites who tempt Department officials will have to work for their bread.

METHOD OF PREPARING REPORTS.

For the purpose of checking up the results of the several sources of information and reducing the possibility of error to a minimum, the final results are made up by a crop-reporting board composed of the Chief Statistician or Chief of the Bureau of Statistics, as chairman, and four individual members, selected from statisticians and officials in the Bureau and members of the special field service called to Washington on report days for that purpose. Thus the plan is to select this board of four members each report day from an available corps of six or eight men well trained and thoroughly informed as to crop conditions and as to the relative value and correctness of the reports from the different corps of correspondents. This board, with several expert computers, meets on report days in the office of the Statistician under the personal supervision of the Secretary or the Assistant Secretary.

After the assembling of the board all reports by States from the several distinct corps of correspondents are brought together in convenient form in parallel columns on final tabulation slips, and the board is thus provided with several separate estimates covering

the same territory and the same crops, made by the respective corps of correspondents, each reporting for a territory with which he is thoroughly familiar. There are also prepared for the board abstracts of the reports on each crop by States from the weekly weather-crop bulletins of the Weather Bureau, issued during the month. With all these data before them each individual member of the board computes separately his own estimate of each crop by States. These reports are then compared and discussed by the board under the supervision of the chairman, and the final figures by States are decided upon. It is interesting to remark how often the reports from the different corps of correspondents are very nearly identical and how often the final figures arrived at by the individual members of the board agree with each other. These State estimates, which are in percentages, are then multiplied into the acreages for their respective States. The sum of these products is divided by the sum of the acreages, giving the percentage for the entire crop for the United States.

METHOD OF ISSUING REPORTS.

Reports in relation to cotton thus prepared by the crop-reporting board are issued on the 3d of each month during the growing season, and reports relating to the principal farm crops and live stock are prepared and made public on the 10th day of each month. In order that the information contained in these reports may be made available simultaneously throughout the entire United States, and that one part of the country may not have the advantage over another, they are simultaneously handed, at a given hour—as at 12 o'clock noon or 4 o'clock p. m.—on report days, to all applicants and to the Western Union Telegraph Company and the Postal Telegraph Cable Company for transmission to the exchanges and to the press. A mimeograph statement also containing such estimates of condition or actual production, together with the corresponding estimates of former years, for comparative purposes, is prepared and sent to a mailing list of exchanges, newspaper publications, and individuals. The same afternoon printed cards containing the essential facts concerning the most important crops of the report are mailed to the 77,000 post-offices throughout the United States for public display, thus placing the most available information within the farmers' immediate reach.

Promptly after the issuing of the report it, together with other statistical information of value to the farmer and the country at large, is published in the "Crop Reporter," an eight-page publication of the Bureau of Statistics, under the authority of the Secretary of Agriculture. An edition of over 100,000 of this Reporter is distributed to the correspondents and other interested parties throughout the United States each month.

CHANGE IN METHODS.

A very great improvement has been made in the special field service by districting the United States and assigning each of the field agents to a definite group of States, which they thoroughly travel over and report on each month. The cotton-producing States have thus been redistricted and the service augmented and perfected there by the appointment of two new agents, men widely recognized as having a thorough knowledge of conditions and of the highest ability and integrity. A special agent has also been appointed for the collection of statistics of tobacco and has entered upon his duties of supplementing the reports from the Bureau correspondents by actual observation in the field. The work of the State statistical agents also is being improved.

Working in harmony and cooperation with the Census Bureau of the Department of Commerce and Labor, the compilation of statistics of the commercial cotton crop has been transferred to the Census Office.

The resignation of Mr. John Hyde as Statistician was accepted, and pending the permanent appointment of a successor to that important office Assistant Secretary Hays was directed to take charge of the Bureau.

FOREIGN MARKETS.

Required by law to collect and disseminate information concerning the exporting of the surplus of farm and forest above the requirements of domestic consumption, and concerning the preparation of such products to meet the special requirements of the various foreign markets, the Division of Foreign Markets of this Bureau has been of much service to the producers and the handlers of the agricultural surplus of this country.

DETAILS OF EXPORTS AND IMPORTS.

The base of the work done is necessarily the assembling and suitable treatment of the statistics of the foreign trade of this country in the products of farm and forest, and this work has been done in the most comprehensive way and with all available detail.

During the past eight years special examination has been given to certain classes of exports. The increasing restrictions of importing countries against the admittance of packing-house products and live meat animals have impelled cattle growing and slaughtering interests to request the aid of this Division; and in partial compliance with this request a complete statement has been prepared to show the extent and directions of this export trade during the last fifteen years.

So many inquiries have been received concerning various features of the exports of agricultural products during a long period of years

that a report has been prepared and published covering the exports as far back as 1851.

Closely related to the disposal of the agricultural surplus is the subject of agricultural imports, and all necessary consideration has been given to this subject, besides utilizing current information. A compilation has been completed covering the last half century of these imports.

Within the last three years more particular attention has been given to the trade of the United States proper with its noncontiguous possessions, in the products of farm and forest.

BALANCE OF TRADE.

A new feature of the examination of statistics of exports and imports of agricultural products is the presentation of the foreign balance of trade in these products for a long series of years. This had not been done by any public office or private individual, and the importance of the matter at once appeared when it was discovered that the great balances of trade in favor of this country have been mostly, if not entirely, because of the products of the farm, which have often been called upon to offset adverse balances in manufactures.

FOREST PRODUCTS.

Particular attention was devoted three years ago to the foreign trade of this country in forest products, and this subject has been one in which current information has since been especially utilized. Statistics in detail of the entire foreign trade in forest products, including both exports and imports, have been compiled for a period of half a century.

EXAMINATION OF COMPETING COUNTRIES.

One of the most useful lines of investigation in behalf of exporters has been an examination of the conditions found in countries which have a surplus in certain agricultural products which meet those of this country in common markets.

General agricultural and industrial conditions have been the subjects of inquiry with regard to Norway, Sweden, Denmark, Spain, Scandinavia, Porto Rico, and the Philippine Islands during the past eight years.

A somewhat allied and more useful and important work has been undertaken with the object of ascertaining in detail the quantities and values of all the agricultural imports of the countries which receive a large share of such imports from the United States, as, for instance, the United Kingdom, Germany, and the Netherlands.

WHEAT AS A WORLD PROBLEM.

Besides such investigations as the foregoing of general trade competition in certain markets, special investigations have been conducted concerning particular products. Wheat is one of these. A special agent of the Department spent over a year in Argentina collecting information concerning the production and marketing of wheat, among other subjects of inquiry.

Wheat again has afforded a special study of its production and prospects in Russia; and, as an important part of the cereal problem of the world, compendious facts concerning the production of cereals in principal European countries have undergone suitable assimilation for public uses.

Sugar is another product of international concern, and information covering the more important economic features of both beet and cane sugar production has received a clear and ample, although compact, presentation in a bulletin prepared in this Division.

PROBLEMS OF COTTON COMPETITION.

Within very recent years no agricultural product has given to the world as great a problem as cotton, and on this account cotton production, actual and potential, in all of the countries where such production is possible, has received a searching examination. The inquiries made with regard to prospective cotton-growing competition have not so far discovered that it has any reasonable immediate prospects, but rather indicates that if such competition is to arise it will be in consequence of years of effort and development. Besides this, it appears that nearly all regions where new production is attempted for commercial purposes produce a cotton like the Egyptian.

DAIRY PRODUCTS.

The low position occupied by the dairy products of this country in principal European markets has excited comment, and the weakness of their representation in foreign trade statistics has led to a special examination of this subject by an agent who has spent several years in England.

PACKING-HOUSE EXPORTS.

In connection with other work done in the interests of cattle growers and meat packers, particular attention has recently been given to all of the principal countries of the world which have a surplus of these products of the farm or ranch for export.

The principal countries of Europe that import packing-house products have afforded a field for a full investigation concerning the kinds, quantities, and values of such products as enter these countries,

together with sources of such imports among the various exporting countries of the world.

TARIFF LIMITATIONS.

In every consideration of an export problem it may be and often is essential that the foreign tariff shall be ascertained and made understandable to the public. Work of this sort has been carried on during the past few years upon a large scale and has embraced the translation and elucidation of all the tariffs of the world governing the importation of packing-house products, of grain and grain products, and of fruits and nuts. A more particular study has been given to packing-house products than to any other.

TRANSPORTATION OF EXPORTS.

Transportation is a prominent subject with which the attention of this Division has been occupied within half a dozen years. The object is to provide the public with useful information concerning the routes over which the surplus products of the farm go to ports for transportation by water to foreign markets; to explain the methods by which shipments are made; to make known the equipment of the various ports for handling export business; to ascertain and make known the rates charged by railroads for moving freight of this sort; and also to ascertain for the service of exporters what lines of steamships are in regular operation, to what ports they carry freight, and what the charges are for various descriptions of farm products.

RESIDENT LONDON AGENT.

This Department maintains a special agent in London for the purpose of being in closer touch with Old World markets and information, and has done so for the past four years. Besides reporting the crop news of other countries he is engaged from time to time upon special inquiries which are of practical concern to producers and exporters in this country.

GROWING SPECIAL SERVICES.

Along with numerous special lines of work carried on and developed within the Bureau has grown a correspondence with persons in all parts of this country who are in pursuit of special information, and in this way a public service has developed which has assumed proportions of considerable size and of increasing utility.

THE LIBRARY.

For the advancement of work in the Department all important publications relating to agriculture and to the sciences upon which it is based are necessary. General treatises, technical monographs, and new scientific periodicals must be available as laboratory tools for the

up-to-date investigators in agricultural science. Over 4,000 such books and pamphlets, including publications of scientific societies, have been added to the Department library during the past year. This growth has been steadily maintained for the past ten years, resulting in a collection of works relative to agriculture, agricultural education and research, as well as the kindred sciences not elsewhere to be found in the country. The collections of works relating to special sciences such as economic entomology, zoology, veterinary science, and botany are of exceptional excellence, both as to size and the number of valuable books of early and late dates.

To facilitate the use of this valuable material, card catalogues, reference lists, and bulletins are maintained and kept as nearly up-to-date as possible.

The present quarters are inadequate for housing this collection of 87,000 books and pamphlets and insufficient in the accommodations for readers and the staff in charge of these books. In addition to space for this valuable possession of the Department, the protection of a fireproof building is most urgent. Such protection, however, will soon be provided by the new Department building.

The resources of the Library are not only made available to scientists at a distance through the system of interlibrary loans, whenever it is possible to do so without interference with the work of the Department, but information is also constantly forwarded in response to letters from all parts of the country. The reference work of the Library has more than doubled in this direction during the past two years as the facilities for meeting the demands have increased.

The publication of a quarterly bulletin of accessions, which is a representative list of current agricultural literature, and of the index cards to the Department publications has been continued. The latter publication, numbering upward of five thousand cards, is of especial value to agricultural colleges, experiment stations, public libraries, and libraries of institutions receiving the Department publications. These cards furnish a permanent index which can be incorporated with the public card catalogue of any library.

The wide distribution of our publications, especially to institutions and scientific societies in this country and abroad and to foreign governments, has resulted in the receipt of a very large number of transactions, periodicals, and foreign documents, which have added much valuable material to the files of periodicals and other serials in the Library. India, Japan, Australia, and Africa, together with other less remote countries, have generously contributed reports of their work in agriculture in exchange for the printed results of work done by the Department. The foreign mailing lists of the Department being in charge of the Librarian, a system of exchanges is thus maintained which is of great benefit to the Library.

OFFICE OF PUBLIC ROADS.

Probably no field of work is of greater interest to the public at large than the improvement of our highways. The Office of Public Roads, as now constituted, represents a distinct stage in the development of the work undertaken by the Federal Government in 1893 by the establishment of the Office of Road Inquiry. At the time of the establishment of the Office, the lack of a knowledge of existing conditions was a serious hindrance to an intelligent application of any plan for road improvement. The name originally chosen for the Office was suggestive of the purpose of Congress, which was to inquire into systems of road management throughout the United States, and into methods of road making, and to disseminate information as to the results of such inquiries.

The most important result which has been attained up to this time, whether produced by influence in or outside of the Office of Public Road Inquiries, is that the people in all parts of the country are now interested in the subject of road improvement, and are seeking such information as will enable them to carry on the work along intelligent lines. It was found, therefore, that the collection of information must of necessity become only one feature of the work of the Office, and that facilities must be provided for answering as well as awaking inquiries. At the same time the necessity for demonstrating scientific and economical methods of road construction instead of mere agitation has been clearly established.

EXPERT ADVICE AND OBJECT-LESSON ROAD WORK.

The work of the Office is primarily educational in character. Its province is to detail engineers and experts to give information and advice. Whenever there is any question as to what road material is best suited for the local conditions, samples of all the available materials may be sent to the laboratory of the Office, where tests will be made to determine the selection of the best material. In the majority of cases the detail of an engineer or expert to make a preliminary investigation and give advice is all that is required. There are, however, communities where it has been found advisable to supplement advice by a practical demonstration of effective road building.

OBJECT-LESSON ROADS.

To meet this need the object-lesson method was adopted on the following plan: A section of road is selected for improvement, and after the proper surveys and estimates have been made by an engineer of the Office, expert foremen and machinery operators are sent out in charge of modern road-building machinery, and the local officials are taught by actual demonstration every step in the proper construction

of a road. Absolutely no expense is incurred by the Federal Government in this work except for the salaries and expenses of the Government employees, the local communities being required to furnish the right of way, all common labor, teams, materials, etc., used in the work.

The total number of experimental and object-lesson roads built under the direction of the Office since its organization is 96, with a total length of about 39 miles. The roads were built in 28 States, the materials used in construction being shells, gravel, brick, oil, tar, sand-clay, marl, stone, burned clay, slag, and steel track.

Four complete road-building outfits were placed in the field at the beginning of the past fiscal year, and their work has continued without interruption. Twenty-one sections of road have been built during the year in nine States, the total length being a little over 9 miles. In the construction of these roads a variety of materials was used, such as stone, shale, burnt clay, sand clay, shells, gravel, and marl. The detailed reports submitted by the engineers in charge of work show a maximum cost of 98 cents and an average cost of 55 cents per square yard for macadam roads, while the average cost of sand clay roads is shown to be 9½ cents. The only burnt clay road constructed was built at a cost of 20 cents per square yard.

In the work done under Government direction there was of necessity a great variation in cost on account of the difference in cost of labor and teaming, amount of grading required, length of haul, and general efficiency of labor.

Since the passage of the act of Congress approved March 3, 1905, creating the Office of Public Roads, steps have been taken to place the field work on a more systematic and businesslike basis than heretofore. This has been to some extent accomplished by increasing the force of engineers and experts and decreasing the number of men detailed as public speakers and lecturers.

A circular of instruction defining object-lesson road work and expert advice within the meaning of the act of Congress, and setting forth the terms under which this Office is prepared to grant assistance is sent out in answer to inquiries on the subject. A blank form of application for expert advice and assistance has been prepared, which is required in every instance to be filled out and signed by the local authorities.

The construction work is at present under the management of trained engineers, who are assisted by experts qualified to operate all road-building machinery. When an object-lesson or experimental road is to be built, complete surveys, plans, specifications, and estimates are prepared and the fullest preliminary information is obtained.

As far as practicable itineraries are made up for each party in the field, covering a considerable period of time, in order that the greatest

amount of work may be accomplished with the least expenditure of time and money. The work is planned so that it may be carried on in the North in summer and in the South in winter, thus avoiding interruption as much as possible.

There appears to be a growing need for the construction and maintenance of roads in the forest reserves. In view of the fact that the Office is maintaining a gradually increasing corps of competent highway engineers and experts, it would seem to be a wise arrangement to utilize the services of these men, wherever practicable, in the construction and maintenance of roads in the forest reserves and other areas which are now or which may hereafter come under Government control.

Heretofore machinery has been borrowed from the manufacturers who have been willing to lend it for the construction of the object-lesson roads. Transportation for men and machinery has usually been secured free of charge from the railroad companies, who have generally shown themselves ready to cooperate on the ground that improved highways directly benefit them. The practice of borrowing machinery and of depending upon free transportation is not, however, the best policy. Gratuitous assistance inevitably tends to hamper that freedom of action on the part of the beneficiary which is essential to the proper performance of the work intrusted to public officials. A plan for leasing machinery at a certain per cent per annum of the list price is being favorably considered, and, if the request for an additional appropriation to make this arrangement possible is granted, it is probable that ten outfits of machinery will be secured and placed in the field. It has been ascertained that this plan is perfectly feasible, and that the machinery can be secured at a fair and reasonable rental. Should the recommendation in regard to an appropriation to cover freight charges meet with approval the old practice of free transportation will be abolished.

EXPERIMENTAL FIELD WORK.

There are vast areas in the country in which stone is not available for road making, and in only a few localities has it been found practicable to overcome the difficulty, on account of the cost of transportation. In such cases the problem is how to obtain a suitable substitute. In some sections of the South roads have been built of mixtures of sand and clay. These roads have generally proved satisfactory, and the efforts of the Office have been directed toward originating special methods for putting such materials to use.

In the great Mississippi Delta the use of burned clay or gumbo has been introduced, under the direction of the Office, with what would seem to be marked success. This is shown by the results obtained on

an experimental burned-clay road constructed at Clarksdale, Miss. Previous to the construction of this road experiments had been made in the laboratory of the Office to determine the best method of burning the clay. This experiment may possibly prove of value to other parts of the country, for instance, in many of the prairie States, in which no other form of road-building material is available. The report from the South on this special form of construction has been most encouraging, one county alone having appropriated \$25,000 to be expended principally in this way in the immediate future. Roads of this nature are said to be more economical, efficient, and lasting than gravel roads which have been constructed in the same section.

In addition to the study of the various methods of construction and their application to those large sections of the country which at present enjoy few if any improved roads, considerable attention has been given to problems in the maintenance of roads. These have particularly to do with the suppression of dust, which has already become in some localities such a nuisance as to warrant considerable expenditure for its cessation. This is a question that has already received the attention of the French Government road engineers, as well as those in England and elsewhere, for the past seven or eight years. It is now occupying the attention of highway engineers in this country.

A treatment which will retain the dust on the surface of a macadam or gravel road is of special value at present, owing to the great damage done to such roads by motor-car traffic, which has the effect of loosening the dust to such an extent as to seriously damage the road.

Extensive experiments for laying dust by the application of oil and coal tar on macadam and earth road surfaces have been conducted by this Office during the past year at Jackson, Tenn., and it is hoped that the data and information to be obtained from these experiments will be of great interest and value. In this connection it might be mentioned that perhaps more inquiries are received concerning the use of oil and tar than on any other phase of the work of this Office. At present there exist little or no exact data on this subject, but it is believed that the experiments referred to will in a great measure answer many of the questions that are now in doubt.

There are at present a number of patented solutions which are recommended to lay the dust on roads more effectively and economically than water sprinkling. It is expected that investigations will be carried on in the laboratory of this Office to ascertain the relative effect of various chemicals which may be used in sprinkling streets and roads.

INSTRUCTION IN HIGHWAY ENGINEERING.

In order to secure engineers having the necessary technical training as a basis, and to supplement such training by special work in highway engineering under the direction of the Office, the plan has been adopted

of appointing graduates of reputable engineering colleges to the position of civil engineer student in the Office of Public Roads. These young men are required to pass rigid competitive examinations before entering the service and receive practical and scientific instruction and work for the period of one year, this being in the nature of a graduate course in highway engineering. At the end of that time they are given a certificate in the nature of a diploma, and may be retained in the service without further examination.

The work of these students includes personal inspection and reports in detail of the methods of construction carried on by different State highway commissions in the States where such work has been systematized and put upon a practical basis. They are also required to make surveys and estimates of the actual cost of building roads under various local conditions. Thorough training in methods of testing the various qualities of road materials is acquired by actual work in the laboratory, so that the value of the different physical properties of the materials may be made clear to them. The work of these engineer students is of great assistance to the Office, in addition to being of much practical value to the public at large.

It is of the utmost importance that the great sums of money appropriated for road improvement throughout the country should be expended wisely, under the direction of properly qualified men. At the present time the number of trained highway engineers is entirely inadequate to meet the demand. It will be of inestimable value to the public if the Office can provide even a few such men each year.

Instruction in highway engineering in schools and colleges throughout the country should receive greater attention at the present time, owing to the rapid development of road building. The Office, so far as its limited facilities permit, will cooperate with the various educational institutions in placing this branch of education on an adequate basis and in inaugurating highway work.

TESTING OF MATERIALS AND SPECIAL INVESTIGATIONS.

One very important feature of the development of the work of the Office has been the testing of materials available for roads in different parts of the country and the investigation of special qualities which are necessary if the most successful results are to be obtained. A large number of tests have been made on all the different kinds of materials which are in use in the construction of highways, and in addition to these routine tests a number of important and valuable investigations have been carried on. By far the greater number of tests have been made for the benefit of State and municipal authorities who have evinced a desire to obtain accurate data to enable them to make a careful and wise selection of the best material at hand. The best indication of the importance of this work is shown by the fact that many of

the State governments are establishing laboratories and conducting work along the same general lines that have been followed in the laboratory here.

The equipment of machinery necessary for testing road materials is also available for testing other materials of construction relating to agriculture, and thus duplication of equipment is avoided by extending the scope of the work of the Division of Tests. It has been possible to undertake several investigations which bear directly upon problems that the farmers of the country have to face.

For some time past numerous complaints from a variety of sources have reached the Department concerning the inferior lasting quality of the steel-wire fencing offered in the market at the present time. Preliminary inquiry showed that these claims were well founded, and a thorough investigation was ordered. Enough has already been accomplished to show that the farmers will derive great benefit from this work.

The interest of manufacturers has been aroused to the extreme importance of this matter, and measures are already being taken in many of the leading manufactoryes to bring about an improvement in the conditions complained of. When it is considered that much of the wire which was produced thirty years ago is still in good condition, whereas the life of wire put on the market in more recent years is often not longer than two to seven years, the money saving to the farmers of the country that will be brought about by the improvement in present conditions becomes apparent.

The fact that in many parts of the country it is difficult to procure wood for fence posts, added to the fact that wooden posts rapidly decay, has stimulated the desire to present the farmers with simple information and directions that will enable them to make use of reinforced concrete. Reinforced-concrete fence posts of various types have been made in the laboratories and tested.

One of the most important qualities possessed by rocks which render them useful for macadam-road building is that of binding power. A study of this important quality has been one of the principal subjects of investigation by the Division of Tests, and several valuable bulletins have been published setting forth the results obtained. In the course of this work it was observed that when some rocks are ground to very fine powders they undergo certain decompositions, owing to the action of water. In view of the fact that many of our large rock deposits are rich in potash, and in view of the extent to which these decompositions are found to take place, it becomes apparent that if the rocks are subjected to a process of fine grinding it is possible that they may be directly available as fertilizers.

The importance of this subject of investigation can not be overestimated, when it is considered that no original source of potash exists

in this country to-day and that we are entirely dependent upon foreign sources of supply for all the potash used annually by our farmers and growers. The further investigation of the possible source of supply will be vigorously pushed in the various bureaus of the Department which are especially equipped for carrying on work of this nature. Under the stimulus of the cement industry, which has grown to enormous proportions in this country, the development of machinery for grinding rock to fine powders has made rapid strides within the past few years, and it is now possible to consider the feasibility, from an economic standpoint, of grinding material which a few years ago would have been out of the question.

In view of the growing importance of the cement industry to-day it is necessary to prosecute studies and inquiries into the actual constituents and character of Portland cement, and to this end an agent of the Office was assigned to work on this subject.

It is proposed during the next fiscal year to carry out investigations along the same general lines, adding from time to time other problems of a similar nature in so far as time and equipment will permit.

COLLECTION OF INFORMATION.

While it is known in a general way that some parts of the country have progressed much further than others in the matter of road improvement, there is little available information regarding what has been accomplished in the various States and counties. If comprehensive statistics were available it would be shown that large sums of money are annually wasted in some sections, while in others surprisingly satisfactory results are obtained at a moderate cost. The Office is now collecting information from every county in the United States in regard to the mileage of improved and unimproved roads, the amount of cash tax, bonds issued, and other information of a similar nature. No more telling argument for reform in wasteful methods can be adduced than to bring home to every county just what results they are obtaining as compared with the results obtained by other counties at a similar cost. This information, which is now being compiled, will be published for each State as soon as completed.

CONVENTIONS.

Government participation in road conventions and the organization of road associations has been considerably curtailed during the past year. Such participation does not seem to be justified when the sole object of the meeting is agitation for the purpose of influencing legislation. Aside from the propriety of the case the results achieved through speeches by Government employees at popular gatherings of this character can scarcely be considered as having a marked influence upon the progress of road improvement in the United States.

There is, however, a field of real usefulness to be reached by means of speakers and lecturers of the Office. Road organizations serve a useful purpose in arousing the people to a realization of the need for better roads. The problem that is most serious to rural communities, and one which it should be the province of specially equipped employees to explain at meetings of local officers and taxpayers, is what they need, how to go about getting it, and what their roads will cost. These speakers should be so well equipped that they can give definite and concise information, on which the local committees may act with safety.

Another branch of this work capable of beneficial results is a cooperative system of lectures in engineering schools throughout the country. As already stated, the demand for skilled highway engineers is already in excess of the supply and the educational institutions of the country should take prompt and adequate steps to meet the situation. Aside from the engineering features, there are many economic questions involved that should be brought out in lectures to students who intend to devote their lives to highway work.

Much of the work embraced in the scope of the Office is of a scientific and technical nature and involves original thought and investigation. Papers should be prepared and read at the meetings of scientific bodies, and properly qualified members of the Office should keep in touch with organizations having under consideration matters bearing in any way upon the purposes for which the Office was established.

OFFICE OF EXPERIMENT STATIONS.

RELATIONS WITH AGRICULTURAL EXPERIMENT STATIONS.

The work of the Office of Experiment Stations has greatly increased during the past eight years, partly by the extension of its business along lines previously established and partly by the addition of new functions. The Office was established to be a clearing house for the agricultural experiment stations organized under the act of Congress of 1887, and as such it has accomplished much valuable service. This Office is charged with the supervision of the Federal funds granted to the experiment stations and issues a considerable number of publications based on their work. The policy has been to make the supervision of these funds more strict and to insist on their application to agricultural research. The result is that the stations have been greatly strengthened as research departments of the agricultural colleges, and their experimental work has been so successful as to win the support of a very large constituency of intelligent farmers. The States have thus been led to supplement the funds granted to the stations by Congress, until now the annual resources of the stations from sources

within the States are equal to those derived from the National Treasury. While many forces have contributed to this end, the influence of the Department is generally acknowledged as an important factor in determining the success and prosperity of the stations and in making our experiment-station system the strongest and most efficient in the world.

It is fitting in discussing the relations of the Department with the stations to call attention to the great influence the latter have had in bringing home to the people the results accomplished. Not only have the stations been a vital factor in making the Department's work more effective, but they have by their own investigations lifted American agriculture to a higher plane.

The Department is cooperating in many ways with practically all of the stations, and as time goes on this work is bound to increase. The stations have now reached a critical point in their development, and they need and will receive all the assistance the Department can give them. In the increasing demand for more light on agricultural practices and the growing interest in rural life generally, the stations must have the means for meeting these demands. It is hoped that Congress will recognize this need, as it is already being recognized by some of the States themselves. There is no direction in which public moneys can be appropriated that will bring more certain and lasting returns than in helping the State experiment stations to do more research work.

The close relations which the Department has held with the stations in recent years has naturally led to a great increase in the number and extent of the enterprises in which the Department and stations have cooperated. By this means the range and effectiveness of many agricultural investigations have been enlarged, and it has been possible to bring the Department's work into vital touch with agricultural industries and agricultural people.

An effort has also been made to perfect and increase the technical publications of this Office in order to thoroughly acquaint investigators of agricultural problems in this Department, the experiment stations, and elsewhere in the United States with the methods and results of such investigations the world over. For this purpose the scope and thoroughness of the review of the literature of agricultural science made each month in the Experiment Station Record have been greatly increased. It may be conservatively asserted that no similar journal approaches it in comprehensiveness within its peculiar field.

The combined index of the first twelve volumes of the Record, with more than 125,000 entries, is a complete key to the literature of agricultural science from 1888 to 1901. The card index of experiment-station literature, now including 26,000 cards, also furnishes a ready means of ascertaining what our stations have done in any line, and is especially useful to agricultural students.

In order to diffuse the results obtained by the stations in the several States among the farmers throughout the country, this Office was directed to undertake the publication of a series of popular résumés of practical features of the stations' work, under the title of Experiment Station Work. Over thirty numbers of this publication have been issued in the general Farmers' Bulletin series, and have had a wide distribution.

PROMOTION OF AGRICULTURAL EDUCATION.

The period covered in this review has witnessed very great activity in the development of agricultural education by the reduction to pedagogical form of the great mass of educational material accumulated by this Department, the experiment stations, and similar agencies in many countries; by the enlargement and better organization of agricultural faculties in our colleges; by the providing of more adequate buildings, apparatus, illustrative material, and other equipment for agricultural instruction, and by the extension of agricultural courses to the lower schools.

The Department has been active in promoting this educational development in various ways, and the Office of Experiment Stations, through its intimate relations with the agricultural colleges, has naturally taken a leading part in this work.

Since the permanent success of agriculture depends on the intelligence and technical knowledge of the farmers, the Department can engage in no more important work than to aid in arousing agricultural people to a keen sense of the importance of establishing in this country a system of public education which will make men and women not only intelligent citizens but also efficient and successful workers in agriculture and the other industries which must ever engage the attention of the great mass of the population. This Department and the experiment stations are largely engaged in gathering the materials which will constitute the future of education in agriculture, and the permanent impression which their work will make on agricultural practice will be largely determined by their success in incorporating the results which they obtain in courses of instruction to be given the youth in agricultural colleges and schools. The Office of Experiment Stations has been encouraged to ally itself as closely as possible with the movement for the extension of agricultural education among the colleges and in the public schools, and the Department will this year recommend to Congress that provision be made for a more active propaganda by this Office in the interests of agricultural education, for it is certain that active work in this direction will produce far-reaching results in the near future.

AID TO FARMERS' INSTITUTES.

Recent years have also witnessed the development of a great system of popular agricultural education for the adult farmer through the farmers' institutes which are now held throughout the country and annually attended by about a million men and women engaged in agricultural pursuits. With the growth of the research work of this Department and the experiment stations it has become very evident that publications alone would not meet the demand for information regarding improved methods of agriculture and the ways in which the results of scientific investigation may be applied to agricultural practice. The absence of agricultural instruction in the schools and the coming on to the farms of millions of people from foreign lands, together with the widespread interest in the results of agricultural research, have made it necessary that means be devised for giving agricultural people instruction by word of mouth which will enable them to understand and utilize the information so largely given out in the publications of this Department and the stations.

For this purpose the farmers' institutes established under public authority in the States and Territories furnish an agency of great usefulness. It has therefore seemed highly desirable that this Department should ally itself closely with the farmers' institutes, and make them efficient instruments for the wide diffusion of the knowledge gained by the Department and other agencies for agricultural research. With this end in view a farmers' institute specialist was appointed two years ago in the Office of Experiment Stations, and efforts have been made to place at the disposal of the institute lecturers the information gained by the Department in many lines.

ESTABLISHMENT AND PROGRESS OF EXPERIMENT STATIONS IN ALASKA,
HAWAII, AND PORTO RICO.

Under various acts of Congress provision was made for agricultural experiment stations in Alaska, Hawaii, and Porto Rico, and the stations were established in Alaska in 1898 and in Hawaii and Porto Rico in 1901. Their administrative control was placed in the Office of Experiment Stations, and a Division of Insular Stations was created.

The headquarters of the Alaska stations were established at Sitka, and branch stations were undertaken at Kenai, Copper Center, and Rampart. In Alaska the first problem was the introduction of agriculture. With a few exceptions about some of the larger villages, little had been attempted in the way of gardening, and nothing done on an extensive scale. Much pioneer work in the way of clearing, fencing, building, etc., was necessary at all these places, but attention was given from the first to the introduction of varieties of economic plants that were thought promising for this country. When tried and

found adapted to the prevailing conditions they were distributed as far as possible, and the settlers urged to take up their cultivation. For a time the principal investigations were with garden vegetables, and it has been demonstrated that the growing of hardy vegetables is possible over a great portion of Alaska as far north as the Arctic Circle. This has made possible a wide extension of gardening, and many villages owe their present supply of fresh vegetables to the demonstration of the experiment stations.

Cereal growing has also been taken up and found practicable away from the coast, rye, barley, and oats having matured every year at the Rampart Station, although situated at $65^{\circ} 30'$ N. latitude. The climatic conditions at Sitka not warranting extensive experiments with cereals, horticultural crops of various kinds are being investigated, and nurseries of hardy fruits, berries, etc., have been established. In addition to introductions, experiments in plant breeding with native fruits are being carried on with promise of success. Soil studies made over large tracts have shown that the seemingly rich soils are peaty and often quite acid. Methods of treatment for correcting the faulty conditions have been found, and the station's results are being widely adopted. Experiments in animal husbandry and dairying have been begun and will be developed as the facilities of the stations will admit.

In Hawaii the station was located adjoining Honolulu, on a tract of land set aside for the purpose by the Territorial authorities. The work in Hawaii has been along the line of the development of agricultural industries, to supplement sugar-cane growing and to secure a greater diversification of crops. The station's experiments with tobacco, although only carried on for the past two years, seem to indicate that it is entirely feasible to grow a type of cigar tobacco but little, if any, inferior to the average product of Cuba. Previous experiments with tobacco had failed, but with attention to varieties, soils, curing, and fermentation a product was secured that was given high rank by experts. Successful efforts to introduce forage plants for the stock ranges have been noted in a number of instances, and a prominent stockman says the success along this one line is worth many times over what the station has cost. Through the station, bananas from Central America have been introduced to supplant the varieties in cultivation for markets of California, Oregon, Washington, etc. The local varieties do not bear shipping well and the Central American varieties are superior in this respect. An effort is being made to develop the growing of citrus fruits for local use, the supply now coming almost wholly from California. Investigations are being made of fungous and insect pests, soils, etc., and many matters of great importance have been discovered and the results given to the public.

The Porto Rico Station was first located on a tract of leased land near Rio Piedras, but after a year it was permanently established at

Mayaguez, where a plantation of about 240 acres was furnished by the insular authorities. One of the chief problems in Porto Rico has been the introduction of improved methods of agricultural practice. To supply information along this line experiments have been inaugurated with nearly all agricultural and horticultural crops grown on the island, and also with others believed to be adapted to the conditions. It has been possible to suggest methods whereby increased production with several crops can be secured with but little more labor and expense than that usually given. Insect pests have been studied and means found for combating a number of the more destructive ones. Experiments with coffee have been in progress ever since the station was established, and trees under investigation yielded double the crop obtained from others in the same plantation. The means by which this result was obtained were pruning, cultivation, and fertilizing, and they may be readily followed by any grower. A large collection of economic tropical plants has been brought together, permitting a comparison of varieties, testing their adaptability, and making possible plant-breeding work on an extensive scale. Experiments with horses, cattle, and pigs have been begun and will be extended as opportunity offers. Other experiments under way are with leguminous plants for forage and rotation crops; rice growing, citrus and other fruits, vegetables, etc. The value of tile drainage has been shown by a demonstration on part of the station farm. This was the first piece of tile drain in Porto Rico, and its efficiency is well recognized.

All the insular stations cooperate in various ways with our Bureaus, giving a wider field to the investigations of the Department, while the stations receive the benefit of our more extensive resources. These stations are all becoming centers of information and demonstration in their several localities, and their power for good is already recognized.

PROGRESS IN NUTRITION INVESTIGATIONS.

The nutrition investigations have been conducted on a cooperative plan by which work has been undertaken in nineteen States and three Territories, in which the Department has been associated with experiment stations, agricultural colleges, universities, and other educational institutions, philanthropic associations, hospitals, and institutions for charity and correction. The Department funds have been supplemented in various ways, including the use of laboratories, apparatus, and the time of investigators, as well as by State appropriations and funds derived from other sources.

During the past eight years the work has developed very materially both in scope and in the importance of the results obtained. During this time some 200 dietary studies have been made and not far from 800 experiments in which the digestibility of different foods was deter-

mined with healthy men under normal conditions. Over 70 experiments with the respiration calorimeter have been completed with 9 different subjects covering a period of two hundred and nine days, during which time the total income and outgo of both matter and energy have been measured and studied. Many experiments have also been made regarding the changes which take place when meat, vegetables, and flour and other cereal products are cooked in different ways, and considerable attention has been devoted to the compilation of the results of Department work, as well as that of other investigators. During the period under consideration some 45 technical bulletins and 26 Farmers' Bulletins and other popular summaries have been issued.

As the nutrition investigations have developed it has been found in the main desirable to concentrate resources upon several problems which have seemed of special importance and to cooperate with institutions where conditions were particularly favorable.

The experiments which have been carried on in California have demonstrated the fact that both fruits and nuts may furnish a considerable portion of the diet at a reasonable cost.

A large number of studies made at the Maine and Minnesota experiment stations have shown that, with all classes of wheat, white bread furnishes the body with more protein and energy, pound for pound, than whole wheat or Graham flour ground from the same lot of grain, since any deficiency in the composition of the white flour is more than offset by its more thorough digestion. Investigations with cereal breakfast foods have also shown that the different commercial brands differ little in real nutritive value, though they differ widely in cost and quite considerably in method of manufacture. The different kinds of bread have been shown to be wholesome and economical foods, and the same may be said of the standard breakfast foods, the use of different kinds of breads and breakfast foods being an easy way to secure that variety in the diet which is considered important as well as pleasing.

The Tennessee investigations have demonstrated that dried legumes (beans, peas, and cowpeas) are quite thoroughly digested and are economical sources of vegetable protein. The thoroughness with which they are assimilated depends in considerable degree upon the method of preparation, being greatest when the legumes are so thoroughly cooked that they are readily masticated and thoroughly mixed with the digestive juices of the stomach and intestinal tract.

As shown by the investigations at the University of Illinois, the losses which meat sustains when cooked in hot water are greater than when dry heat is used, as in roasting or baking, though in all cases the losses of nutrients are small. Dry heat applied in different ways develops flavor to a greater extent than cooking in hot water. The

different kinds and cuts of meat differ somewhat in the thoroughness with which they are digested, as do meats cooked in different ways. However, it may be said that meats as a class are very thoroughly assimilated by the average man under normal conditions.

The experiments carried on at Middletown, Conn., with the aid of the respiration calorimeter have furnished very accurate data regarding the actual energy requirements of the body, the relative energy production at work and at rest, sleeping and waking, and under other conditions; the normal variations in body temperature, effect of varying amounts of carbon dioxid and moisture in the air upon bodily comfort, the relation between food consumption and excretory products, and similar topics; they have also supplied valuable data for the discussion of problems of ventilation and hygiene. Recently, as a part of this work, very important and useful factors have been deduced with which it is possible to compute the carbon dioxid and energy output of man at rest and performing muscular work of different degrees of severity, and also the energy expended per day by men engaged in any one of the ordinary occupations or trades. When these quantities are known it is possible to form an estimate of the actual food requirements.

A résumé of the results of the nutrition investigations should take into account the extended use which has been made of the technical publications summarizing the results of the work, and also of the popular summaries which have been issued at frequent intervals. These publications are used as text-books in a large number of schools, colleges, and medical schools throughout the country and are widely read in American homes, as is shown by the constantly increasing demand for them. The very large correspondence of the Department regarding nutrition problems is another indication of the widespread popular interest in the work.

ESTABLISHMENT AND DEVELOPMENT OF IRRIGATION AND DRAINAGE INVESTIGATIONS.

In 1897 Congress appropriated \$10,000 to enable this Department to investigate irrigation laws and irrigation practice. The present Irrigation and Drainage Investigations, for which \$74,200 was appropriated in 1905, is the outgrowth of this initial appropriation. It was the beginning of systematic study by the General Government of the agricultural and legal features of irrigation—the two features which have a controlling influence on the peace and enduring prosperity of irrigated districts.

The need of more definite information on these subjects was shown in the wide discrepancy of view regarding the duty of water as exhibited in court decrees fixing water rights and in the water-right contracts of

canal companies, the quantity allowed for the irrigation of an acre of land one year varying all the way from enough to cover it to a depth of 6 inches to enough to cover it to a depth of 500 feet. The value of these measurements of the duty of water has been shown in preventing decrees for excessive amounts of water and the chaos, injustice, and unending litigation which came from decisions and agreements which gave one man more than he could use profitably and another less than his crops required.

These measurements of the quantity of water used in ordinary practice have been followed by more careful experiments to determine the frequency of irrigation and the amount of water which should be applied at each irrigation in order to get the best results. The object of these investigations is to furnish the information needed to establish a proper system of rotation, prevent the injury of land by excessive use of water, and reduce to a minimum the losses from seepage and evaporation.

Accompanying the measurements of the duty of water have been measurements of the losses from seepage and evaporation in canals and ditches. These losses were far greater than had been commonly supposed, amounting in many instances to more than half the water turned in the head-gates.

The determination of seepage losses has been followed by experiments in the lining and puddling of ditches to lessen such losses, which have been an active agency in improving this feature of irrigation practice and increasing the service which streams will render. It has also retarded the extension of the area injured by seepage water and alkali.

An important feature of irrigation development in the United States is that each year thousands of acres of new land have to be cleared of brush, graded, and ditched for the distribution of water. Another fact is that much of this work is done by settlers to whom the whole subject of irrigation is strange and new. Nothing could have been more wasteful than to leave each of these beginners to find out for himself how to do this work, and the Department has rendered valuable aid by the publication of practical bulletins describing the tools and methods of clearing and grading land, giving the cost of this work, and explaining the methods of applying water suited to different soils, crops, and climates. The information given in these bulletins has been collected in widely separated sections of the country and includes practically every method of applying water to be found in this or any other irrigated country.

The studies of irrigation laws and irrigation institutions have included the collection of facts showing the character and amount of the water rights and the methods of their establishment in the different

Western States. Having the facts before them, the people of those States have been able to determine what sort of legislation was required for their improvement, and it has been the policy of the Department to let these facts furnish their own argument, the Department confining itself to the statement of the general principles which should underlie the control and management of public water supplies. It is not possible to speak certainly regarding the influence which these investigations have exerted, but it is known that in the eight years since they were begun there has been a progressive interest in the reform of irrigation statutes and in the laws and customs which determine the relations of irrigators to each other. The facts presented in the official bulletins of this Department have been largely quoted and the laws enacted have been in harmony with the general policy advocated by this Department.

Irrigation and drainage are inseparable. In every irrigated district some lands have to be drained. Without this the soil water rises to the surface and renders the land unproductive from excess of water or alkali. The drainage investigation grew out of need for plans for removing the excess of water coming from seepage and waste on irrigated fields. It has been extended to embrace the entire country, where in many sections drainage is a fundamental necessity if the full productiveness of the soil is to be secured. The drainage problems which have been dealt with have included the preparation of plans and giving expert advice about large projects and the making of studies to determine the feasibility of drainage and the methods to be followed in many parts of the Mississippi Valley.

Experiments are also being made to determine how far drainage can be made to protect hillsides from the destructive effects of erosion. In the whole United States there are about 100,000,000 acres of swamped and overflowed lands which can be reclaimed only through drainage, which will change these from unhealthful and worthless areas into some of the most productive farm lands in the country.

To these two branches of rural engineering there was added last year the study of farm machinery and appliances used in agriculture. The tools and implements used on the American farm cost approximately \$100,000,000 a year. The farmer must make this large outlay because it is only through this means that he can offset the scarcity and high price of farm labor; but farm implements are becoming each year more complex and costly and require a greater knowledge of mechanical principles to select and use them. The purpose of this work is to aid the present generation of farmers in acquiring this knowledge and to aid the agricultural colleges and experiment stations in the preparation of courses of instruction for the more effective equipment of the coming generation.

NEW BUILDINGS FOR THE DEPARTMENT.

The need of better buildings for the Department of Agriculture has long been felt. For the past fourteen or fifteen years attention has been called from time to time to the inadequate structures, especially in so far as relates to laboratory uses. Six years ago systematic effort was undertaken to secure buildings commensurate with the needs of the Department. Preliminary appropriations were made for plans, which were followed eventually by appropriations for the buildings themselves. The Department now has under construction two wings, constituting a part of a series of buildings which, when completed, it is believed will meet the requirements of the work. Every effort has been made to have these buildings constructed with due regard to the important work which the Department is conducting and in recognition of the fact that Washington itself is destined to have a system of public buildings second to none in the world. The present structures, which will cost about \$1,500,000, will be completed in two years, and by that time it is hoped that further appropriations will be available for a continuation of the building work inaugurated.

GROWTH OF THE DEPARTMENT.

The history of this Department's growth during the past eight years may be epitomized in the statement that the appropriations for its use have increased from \$2,500,000 in 1897 to considerably over \$6,000,000 in 1905, and that this increase in appropriations has been accompanied by a much greater increase in the amount of work done. Not only has the work of the Department been vastly augmented, but its scope has been correspondingly broadened and its practical value heightened.

Another interesting evidence of the growth of the Department during the past eight years is afforded by the records of the appointment clerk's office. These show that the total number of persons on the rolls of the Department of Agriculture July 1, 1905, was 5,446. Of this number those rated as scientists and scientific assistants numbered 2,326. On July 1, 1897, the total number of persons on the rolls of the Department was 2,443, of which number those rated as scientists and scientific assistants numbered 925. These figures show an increase in the total force during these eight years of 3,003 persons, while the increase in the number of those rated as scientists and scientific assistants was 1,401.

CONCLUSION.

It has been my gratifying task in the foregoing pages to present to you, and through you to the American people, a pen picture of the American farmer as he is to-day; to make clear the position of the

farming industry and its relation to other industries; its wonderful productiveness and its large contributions to the general prosperity the country enjoys.

I have also sought to point out some of the more important work accomplished by the Department, illustrative of the methods by which it seeks to work for the practical benefit of the farmer. The work of this Department is twofold. It must seek to add to the sum of intelligence of the man and to increase the productive capacity of the acre. In this important work it has the hearty cooperation of the State agricultural colleges and experiment stations, all of them working with the Department of Agriculture toward the same great end. The gratifying evidences of well-being in our farming community, the extraordinary progress made in the past few years, and the rapidly enlarging recognition of the true position of the farming industry in the economic life of this country are mainly the result of this continued and combined effort on the part of these agencies to add to the sum of the farmer's knowledge, and must be regarded as the triumph of intelligence in the application of scientific knowledge to the tillage of the soil. This is so obviously true that it would seem superfluous to urge the generous maintenance of the Department in its grand work. Great as has been the work undertaken and accomplished, gratifying as have been the results, as shown in the first few pages of this report, be it remembered that we are still at the threshold of agricultural development, and that the educational work which has led to such grand results has only been extended as yet to a portion of our agricultural population. There is not an intelligent, patriotic citizen in the Union who will not say with his whole heart, "Let the good work go on."

Respectfully submitted.

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *November 22, 1905.*

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